ZigSense™

Wireless Sensing Technology

ZigSense Wireless Sensors

Document Ref.
ZS24-001-MAN

This product is designed and manufactured in Melbourne, Australia

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SAFETY AND COMPLIANCE

READ THE MANUAL

Read the instruction manual carefully before using the equipment. Ensure to comply with all instructions in order to prevent personal injury or damage to property. It is the responsibility of the user to receive clarifications and answers to any questions prior to operating the equipment

GENERAL INFORMATION

ZigSense wireless sensors “the product” use ZigBee radios that have been tested and found to comply with the limits set for Class A of digital devices related to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when operated in a commercial environment. Equipment that use wireless communications radiates radio frequency energy and must be installed and used in accordance with the instructions

RF EXPOSURE INFORMATION

ZigSense wireless sensors operate using Digi International Inc. XB24 or XBP24 2.4GHz radios. The user is required to maintain the following separation distances between the antennas and any person operating in the vicinity as follows: 20 centimetres or more for antennas with gain < 6dBI and 2 metres or more for antennas with gain > 6dBi Operating at shorter distances then what is specified above is not recommended

USE OF EXTERNAL ANTENNAS

ZigSense nodes are supplied with default antennas. Use of any other unauthorized antennas or any other modifications not expressly approved by the supplier or the official body responsible for compliance could void the user's authority to operate or use this product

INTERNAL BATTERY

ZigSense nodes include (**when inserted by the user**) internal Lithium batteries. Lithium batteries are only to be serviced by technically skilled personnel. If a battery is removed from the device it should be returned to the supplier or disposed of in accordance with local regulations. There is a risk of explosion if the battery is replaced by an incorrect type

EXTERNAL POWER SUPPLY SOURCE

ZigSense nodes may be powered by an external DC power supply of 12VDC max. The power supply manufacturer shall be an approved limited power source compliant with the requirements of IEC60950-1 clause 2.5 and the voltage limitations imposed by the ZigSense power supply specifications

NON HAZARDOUS AREA

ZigSense node is suitable for operations in **non-hazardous locations only**. Do not replace any part of a ZigSense node unless power has been switched off

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1. GENERAL

1.1 ABOUT THIS MANUAL

THIS USER MANUAL HAS BEEN WRITTEN TO ASSIST IN THE INSTALALTION, CONFIGURATION AND THE INTEGRATION OF ZIGSESNE WIRELESS SENSORS. PLEASE READ THIS MANUAL CAREFULLY AND FOLLOW THE INSTRUCTIONS IN ORDER TO ACHIEVE THE BEST AND SAFEST RESULTS

1.2 PRODUCT WARRANTY

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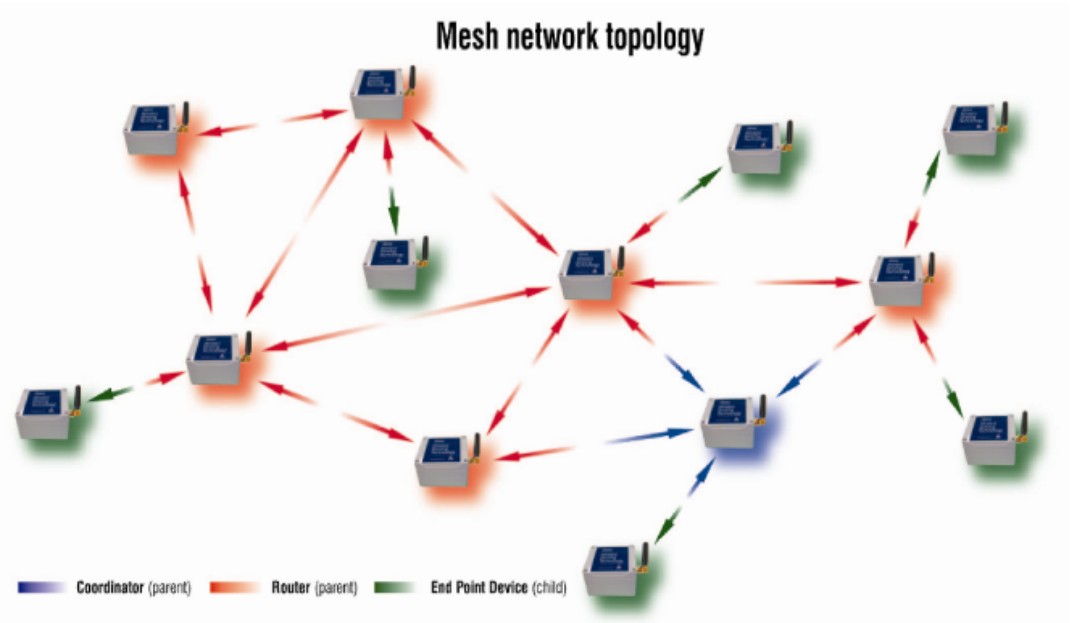
2. INTRODUCTION TO WIRELESS MESH NETWORKS

2.1 WIRELESS MESH NETWORK

Wireless mesh networks are designed to provide high bandwidth communications channels between wireless nodes over a specific coverage area. Wireless nodes cooperatively make data forwarding decisions based on their 'knowledge' of the network. In a mesh network each node is connected to other neighbouring nodes that exist in the same area. A wireless node normally needs only to transmit to its neighbour. If a node drops out due to hardware failure or other reason, its neighbour should be able to find another route to transfer the data to the next station

Mesh networks use various communications protocols. One protocol is the Ad hoc On-Demand Vector (AODV) routing. When using AODV protocol the network is silent until a connection is needed. When a node requires a connection it broadcasts a request for connection to the network. Other nodes on the network forward the request and at the same time record the ID of the requesting node. Assuming routes were initially established throughout the network, the receiving node sends a response to the sender. Communications between the stations are established based on the least number of hops through other nodes. When a communications link fails a routing error is sent back to the original transmitting node and the process repeats itself



2.2 ZIGBEE BUILDING BLOCKS

ZigBee is one implementation of wireless networks. It is a proprietary standard, low cost, low data rate and low power wireless mesh network. The advantage of low power consumption is translated to long operating life using smaller batteries. ZigBee mesh network adds high reliability to network communications potentially enabling it to be used in a variety of applications. A ZigBee network is made of the following building blocks:

ZigBee Coordinator (CO) – Only one coordinator can operate in a given single network. A Coordinator is defined as a 'parent' to other network nodes known as its ‘children’

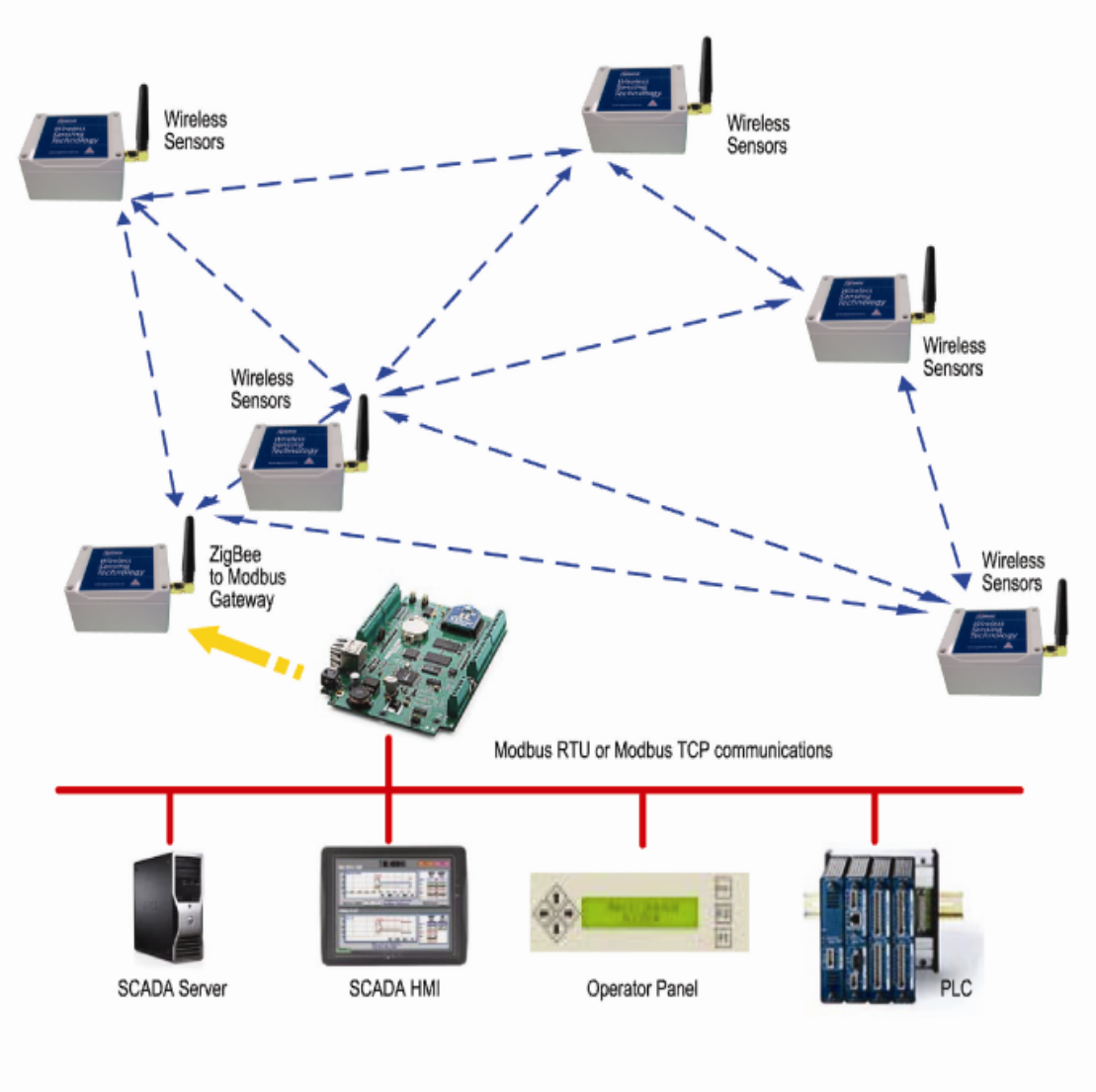
ZigBee Router (RO) – A router passes data between end point (EP) nodes and the coordinator. A router (RO) is defined as a 'parent' to end points

ZigBee End Point (EP) – An EP passes data to its 'parent' either directly or indirectly (through a 'parent' router). An end point (EP) is defined as a 'child'

3. ZIGSENSE PRODUCT DESCRIPTION

3.1 ZIGSENSE™ PRODUCT LINE

ZigSense line of low power wireless sensing nodes, utilizes ZigBee wireless mesh network technology as its core Ad Hoc On-Demand Distance Vector (AODV) routing and protocol communications channel



ZigSense nodes (like ZigBee nodes) are divided into three distinct types:

ZigBee definitions	ZigSense definitions
Coordinator (CO)	Central Gateway Unit (CGU)
Router (RO)	Remote Router Unit (RRU)
End Point (EP)	Remote End Unit (REU)

3.2 ZIGSENSE CENTRAL GATEWAY UNIT - (CGU)

The gateway is the ZigSense wireless network 'manager'. It contains an embedded ZigBee coordinator (CO) that 'manages' the wireless network section

The GATEWAY (CGU) is a fully functional device it must be powered continuously

THERE IS ONLY ONE GATEWAY IN A GIVEN ZIGSENSE NETWORK

The gateway internal coordinator exchanges data with:

- Remote End Units (REU) – directly, or indirectly via routers
- Remote Router Units (RRU)

The gateway (CGU) functionality will be discussed in more details in chapter 8.2

3.3 ZIGSENSE REMOTE ROUTER UNIT - (RRU)

The ZigSense router can be considered as a network extender. Multiple routers may exist in a given wireless network. A router enables data to be passed through between:

- End points (EP) and coordinator (CO)
- End points (EP) to End Points (if EP was programmed to do so)
- Other Routers (RO) to Coordinator (CO)

The ROUTER (RRU) is a fully functional device it must be powered continuously

If an end point is able to reach the coordinator directly it will not necessarily communicate via a router

3.4 ZIGSENSE REMOTE END UNIT - (REU)

ZigSense remote end unit (REU) contains input and output (IO) points. The REU monitors various parameters as inputs and is also able to control outputs to a limited degree. REU can be interfaced to external or internal sensors

The REU is designed as a low power device. It is normally powered by external power supply and includes an internal backup battery. In order to conserve battery power, the REU utilizes a sleep & wake-up cycle (see Sleep Cycle in chapter 9.0)

Data from REU nodes arrives at the gateway (CGU) over the ZigSense wireless network either directly to the gateway (CGU) or via a router (RRU)

The Remote End Unit (REU) wireless node is normally powered by an external DC power supply. An internal battery is normally used as a backup. In certain circumstances the battery can be used to power the node for a long time

4. INTRODUCTION TO WIRELESS COMMUNICATIONS

4.1 RF AND WAVELENGTH

Radio Frequency (RF) waves are synonymous with wireless communications. A wireless wave (RF) can be described by its frequency or its wave length. Frequency and wave length are inversely proportional to each other. The higher the frequency the shorter is the wave length.

F = 1 / λ
Where:
F - Frequency
λ - The wave length (pronounced Lambda)

All wireless communications systems are affected by a number of factors that should be taken into considerations

- The transmitting device
- The receiving device
- The environment through which the device communicates through
- Additional tools required to achieve good communications e.g. antenna

A wireless transmitter encodes data and forms it into RF wave using electronic means. The RF wave is fed into an antenna in order for it to be transmitted further. The TX power output is measured in Watts or dB signal strength

A wireless node receives RF waves utilizing its own antenna. The receiver decodes the signal back to its original format originally sent by the transmitter. Since there are other RF signals in the air, the wireless receiver is designed to filter out the unwanted signals.

The space between the transmitter and the receiver is known as the 'RF environment'. Physical barriers and electro-magnetic interference ('noise') can exist within the 'RF environment' and influence the systems ability to transfer the information from point A to point B. Such barriers can be trees, walls, buildings, hills, wind, rain etc.

Attaining open space and line of sight (LOS) between the transmitter and the receiver is essential in order to achieve greater communications range

The following two LOS parameters are to be considered:

Visual Line Of Sight (LOS) – The ability to physically view site B from site A

RF Line Of Sight (Invisible LOS) – Radio manufacturers advertise line of sight (LOS) range figures. However, being able to see site B antenna from site A antenna ***should not be confused with RF line of sight.*** Every obstacle in the path degrades the RF line of sight figure. The type of obstacle, the location of the obstacle, and the number of obstacles will all play a role in the overall path loss.

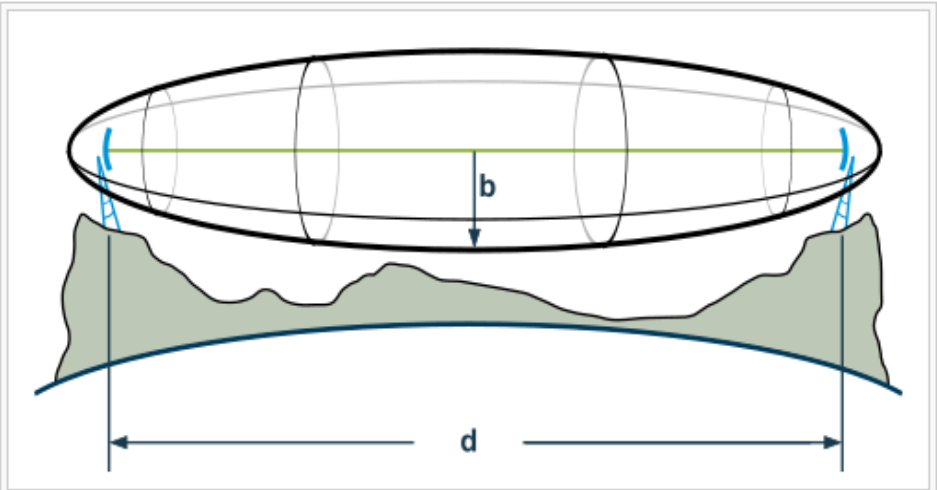
Imagine the connection between antennas as lines radiating in an elliptical path between the antennas in the shape of a Rugby or American football. Directly in the centre of the two antennas the RF path is wide with many potential pathways. A single obstacle in the middle of the path will have minimal impact on path loss.

As you approach each antenna, the meaningful RF field is concentrated on the antenna itself. Obstacles located close to the antennas will cause dramatic path loss. This non-visual elliptical shape is known as **FRESNEL ZONE**.

4.2 FRESNEL ZONE – THE BASICS

Fresnel Zone was named after the French physicist Augustine-Jean Fresnel.

Unobstructed, radio waves will travel in a straight line from the transmitter to the receiver. But if there are obstacles near the path, the radio waves reflecting off those objects may arrive out of phase with the signals that travel directly and reduce the power of the received signal. On the other hand, the reflection can enhance the power of the received signal if the reflection and the direct signals arrive in phase. This may result in a counter intuitive finding where reducing the height of an antenna actually increases the (Signal +Noise)/Noise ratio.



Fresnel zone: d is the distance between the transmitter and the receiver, b is the radius of the Fresnel zone.

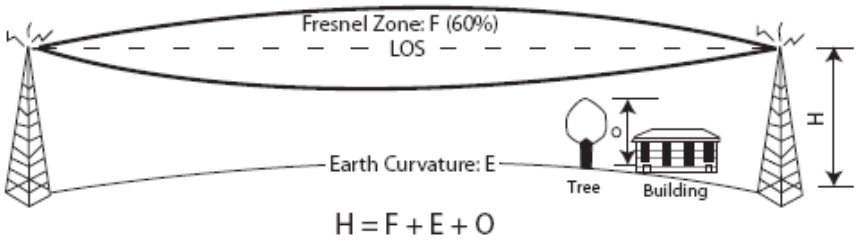
Fresnel provided a formula to calculate where the zones are, where obstacles will cause mostly in-phase and out-of-phase reflections between the transmitter and the receiver.

Obstacles in the first Fresnel zone will create signals that will be 0 to 90 degrees out of phase, in the second zone they will be 90 to 270 degrees out of phase, in third zone, they will be 270 to 450 degrees out of phase and so on. Odd numbered zones are constructive and even numbered zones are destructive.

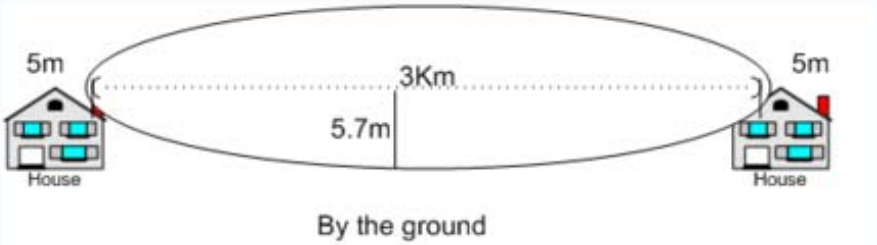
To maximise receiver strength, one needs to minimise the effect of the out of phase signals by removing obstacles from the radio frequency line of sight (LOS). The strongest signals are on the direct line between transmitter and receiver and always lie in the 1st Fresnel Zone. Be sure you know the distance between antennas. This is often underestimated. If it is a short-range application make sure to pace it off. If it is a long-range application, establish the actual distance with a GPS, Google Earth or Google Maps.

The concept of Fresnel zone clearance may be used to analyze interference by obstacles near the path of a radio beam. The first zone must be kept largely free from obstructions to avoid interfering with the radio reception. However, some obstruction of the Fresnel zones can often be tolerated, as a rule of thumb the maximum obstruction allowable is 40%, but the recommended obstruction is 20% or less

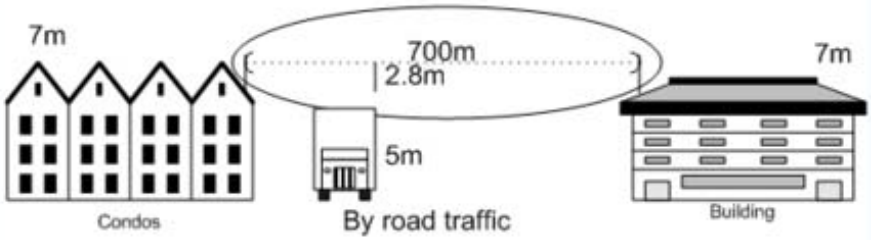
Objects or parameters that may disrupt a Fresnel Zone



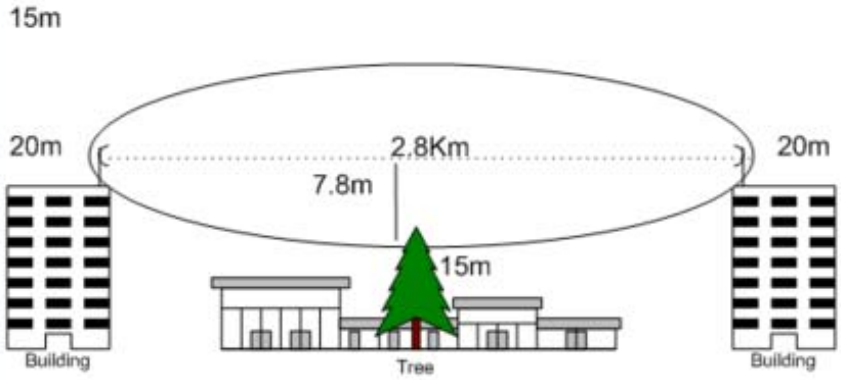
$$H = F + E + O$$



By the ground



By road traffic



By an obstacle

4.3 RF BASICS FOR ZIGSENSE NETWORKS

4.3.1 LICENSE FREE FREQUENCIES

ZigSense network operate using license free frequency bands. These are known as ISM band (ISM – Industrial, Scientific and Medical). License free frequency bands differ from one country to the other. As an example:

2.4GHZ – Worldwide
902 – 928MHz USA
915 – 928MHz USA, AUSTRALIA, ISRAEL
868MHz EUROPE

4.3.2 MILLI-WATT AND DBM

ZigSense RF transmitter power is measured in milli-Watts (mW).
ZigSense RF transmitter power can also be measured and described in decibels (dBm) reference to 1mW of power

4.3.3 RF POWER GAIN

A 1 fold of RF power = 0dBm of signal
A 2 fold increase in RF power = 3dBm of signal
A 10 fold increase in RF power = 10 dBm of signal
A 100 fold increase in RF power = 20 dBm of signal

4.3.4 RF FADE MARGIN

Fade margin is a term critical to wireless success. Fade margin describes how many dB a received signal may be reduced by, due to unknown loss, without causing system performance to fall below an acceptable value. A fade margin of no less than 10dB in good weather conditions will provide a high degree of assurance that the system will continue to operate effectively in a variety of weather, solar, and RF interference conditions

Rule of : Always apply a default **fade margin** figure of **10dB**

4.3.5 PATH LOSS BASICS

In a clear path through the air, radio signals attenuate with the square of distance. Doubling range requires a four-fold increase in power.

When communicating outdoors:

- Halving the distance decreases path loss by 6dB.
- Doubling the distance increases path loss by 6dB.

When communicating indoors:
Path losses tend to be more complex - Use a more aggressive figure as your rule of thumb:

- Halving the distance decreases path loss by 9dB.
- Doubling the distance increases path loss by 9dB.

The higher the frequency the shorter the distance and the lower the ability of the RF wave to overcome obstacles.

4.3.6 PARAMETERS AFFECTING PATH LOSS AND SIGNAL STRENGTH

Metal shielding such as walls with re-enforced concrete, shipping containers, stainless steel liquid tanks are probably the worst 'enemy' of wireless communications. An antenna that is installed inside a container or is shielded by a wall of containers will not be able to transmit its data. Recommendation: Avoid metal shielding or find a way to communicate 'around' or 'over' the obstacle by installing the antenna away from the transmitting/receiving node

High antenna elevation is the most effective way to reduce path loss. Assuming antennas at approximately 2 metres high above ground, then line of sight is about 5 KM while taking into consideration earth's curvature.

Recommendation:

- Avoid tall obstacles between the nodes or elevate your antennas
- Weather condition affects wireless communications. Increased moisture in the air (rain) increases path loss. The higher the frequency - the higher the path loss
- Thick leafy areas such as orchards or forests make it very difficult for RF waves to penetrate through the foliage. Elevate your antennas above the trees canopy

Industrial installations often include many reflective obstacles leading to numerous paths between the antennas. The received signal is the vector sum of each of these paths. Depending on the phase of each signal, they will be added or subtracted.

Recommendation: In multiple path environments, simply moving the antenna slightly can significantly change the signal strength

Use this general formula to estimate reliable communications levels:

(TX Power + TX Antenna Gain) – (Path loss – Cabling loss) + (RX Antenna Gain – 10dB Default Fade Margin) > RX Radio sensitivity (or the RF noise floor)

TX power, RX sensitivity and Antenna gain figures are available from RF hardware manufacturer's specifications. Path loss and RF noise floor (Noise Floor to be considered in an environment of heavy RF interference) are the two parameters that must be established per installation

4.3.7 CABLE LOSS

The high frequencies being transmitted through the antennas normally don't propagate particularly well through cable and connectors. Always ensure the use of high quality RF coax cable between the Transmitter (or Receiver) antenna connector and your antenna and ensure that all connectors are high quality and carefully installed.

Always factor-in a 0.2 dB loss per coaxial connector in addition to cable attenuation

4.3.8 CALCULATING LINK MARGIN

The link margin formula is a simplified version of the previous formula (see chapter 4.3.6)

Link Margin = Transmit Power - Receiver Sensitivity + Antenna Gain – Path Loss

A link margin of 10dB or above is a good indication for reliable communications

It is always recommended to measure the path loss and the RF noise conditions. For the majority of applications, there are some rules of thumb to follow that will help ensure a reliable wireless link

- To ensure basic fade margin **in a perfect line of sight application, do not exceed 50% of the manufacturer's rated line of sight distance**. This in itself yields a theoretical 6dB fade margin – still short of the required 10dB 'default'
- Degrade more aggressively if you have obstacles between the two antennas, but not near the antennas
- Degrade to 10% of the manufacturer's line of site ratings if you have multiple obstacles, obstacles located near the antennas, or the antennas are located indoors.

Below are two cases where link margin is calculated over the same distance but using different TX power output and different RX sensitivity

Case 1: Distance between point A and point B = 10 metres TX Power: 50mW

TX Power = 16.5 dB (50mW)
Antenna Gain = 2.5 dB
Path loss = 81dB (assuming 10 metres distance @2.4GHz)
Cable loss = 0 (no cables)
RX antenna gain = 2.5dB
Fade margin = 10dB (default 'rule of thumb' figure)
RX Sensitivity = -102dB

Link Margin=TX Power – RX Sensitivity + Antenna Gain – Path Loss – 10dB Fade

Link Margin = 16.5 – (-102) + 2.5 - 81 – 10 = 30 dB

Case 2: Distance between point A and point B = 10 metres TX power: 2mW

TX Power = 3.0 dB (2mW)
Antenna Gain = 2.5 dB
Path loss = 81dB (assuming 10 metres distance @2.4GHz)
Cable loss = 0 (no cables)
RX antenna gain = 2.5dB
Fade margin = 10dB (default 'rule of thumb' figure)
RX Sensitivity = -96dB

Link Margin=TX Power – RX Sensitivity + Antenna Gain – Path Loss – 10dB Fade

Link Margin = 3.0 – (-96) + 2.5 - 81 – 10 = 10.5 dB

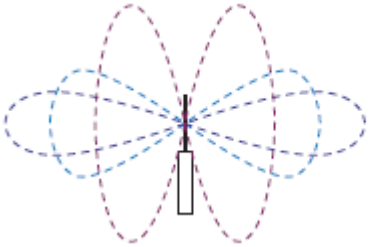
4.3.9 ANTENNAS

Antennas increase the effective power of the transmitter by focusing the radiated energy in the desired direction. Using the correct antenna and ensuring correct polarisation not only focuses power into the desired area but it also reduces the amount of power broadcast into areas where it is not needed.

Most antennas broadcast in a horizontal pattern, so vertical separation is more meaningful than horizontal separation. If you need to install two antennas next to each other ensure to separate the antennas with like polarisation and a minimum distance of two wavelengths: About 25 cm separation for 2.4GHz or 70 cm separation for 900MHz

Non-directional (OMNI) antennas

Focus their energy evenly in a doughnut shape around the antenna



Directional (YAGI) Antenna

Focus their energy in one direction

5. SITE SURVEY & RANGE TESTING

5.1 SITE SURVEY

ZigSense range tester kit model **ZS24-RGR-001** was designed to assist engineers, system integrators, electricians and installers to successfully conduct wireless communications site surveying activities and establish optimum paths and locations of ZigSense wireless nodes. The kit contains a pair of wireless nodes (Coordinator + End Point) that were 'matched' as a pair during production.

5.2 RANGE TESTER

A strong signal strength level of -42dBm is indicated by a lit LED near the HI position. An acceptable level of signal quality level of -67dBm is indicated by a lit LED at ½ way between the LO and the HI positions. Signal level of -91dBm is considered too low and should be avoided

How to interpret the signal level quality readings

6. ZIGSENSE HARDWARE

6.1 CENTRAL GATEWAY UNIT (CGU)

The ZigSense central gateway unit (CGU) model ZS24-CGU-001 is the only point in a ZigSense system that interfaces between two communications networks:

Network A: A wireless network of ZigSense wireless nodes
Network B: A wired network of control and monitoring devices (PLC, SCADA, HMI)

The gateway (CGU) contains the following communications ports:

Port A: Wireless port. A built-in ZigBee wireless coordinator
Port B: Serial communications port. MODBUS RTU is the default communications protocol used to interface to: PLC, Data logger, Instrumentation and HMI and SCADA stations
Port C: USB port. Used for ZigSoft software set-up, maintenance, and diagnostics

Local Operator's HMI

In addition to its set-up software package ZigSoft (see Chapter 10.0) the network can be, to a limited degree, set-up and viewed for maintenance purposes by stepping through its built-in text menu using the on-board keypad and LCD display

The gateway must be used by the system integrator (SI) to authorize new nodes

Central gateway unit (CGU) requires continuous power. A built-in rechargeable Lithium battery provides power for a limited period during external power outage

6.2 REMOTE ROUTER UNIT (RRU)

ZigSense router model ZS24-RRU-001 contains ZigBee router functionality.
A router is an optional node used mainly as a network extender.

A router enables data to be passed between:

- End points to Coordinator **[EP ←→CO]** via the RO
- End point to End Point **[EP ←→ EP]** if EPs were designed to do so
- Router to Routers **[RO ←→ RO]**

A router must join the network before it can be used for data transfer

A router must powered continuously

6.3 REMOTE END UNIT (REU)

ZigSense remote end unit (REU) model ZS24-REU-001 is known, under the ZigBee wireless network specifications, as an End Point (EP). The REU contains input and output (IO) points. The REU is designed to monitor and control physical parameters; it can be interfaced to external or internal sensors - Analogue, Digital or Serial

The Remote End Unit (REU) is designed as a low power device. It is normally powered by an external power supply of 12VDC MAX or by an internal Lithium backup battery

Data from a REU arrives at the ZigSense gateway (CGU) either directly **[EP ←→CO]** or optionally via a ZigSense router (RRU) **[EP ←→ RO ←→ CO]**.

To conserve battery power, the REU is programmed to operate under pre-defined Sleep - Wake UP cycle. Being a low power node it is considered a reduced functionality device under the ZigBee wireless network specifications

Modifying SLEEP & WAKE-UP cycle affect the REU internal battery current consumption and the length of the battery life. For more details please see the discussion about the Sleep Cycle (see chapter 9.0)

7. IO ACCESSORIES

7.1 ANTENNA

One of the more important accessories of a wireless network is the antenna.

Antennas are designed to increase the effective power of the transmitter by focusing the radiated energy in the desired direction. Using the correct antenna and ensuring correct polarisation not only focuses power into the desired area but it also reduces the amount of power broadcast into areas where it is not needed.

Most antennas broadcast in a horizontal pattern, so vertical separation is more meaningful than horizontal separation. If you need to install two antennas next to each other ensure to separate the antennas with like polarisation and a minimum distance of two wavelengths: About 25 cm separation for 2.4GHz or 70 cm separation for 900MHz

Below is a short list of a number of antennas that can be used in a ZigSense network

Small and flexible antenna
A24-HG2402-RD-RSF: 2dBi 'rubber duck' OMNI antenna
A24-HG2403-RD-RSF: 3dBi 'rubber duck' OMNI antenna
A24-HG2405-RD-RSP: 5dBi 'rubber duck' OMNI antenna

Mid size base station OMNI antenna
A24-HGV-2404: 4dBi fibreglass OMNI antenna
A24-HGV-2406: 6dBi fibreglass OMNI antenna
A24-HGV-2408: 8dBi fibreglass OMNI antenna

Directional High Gain antennas
A24-HG2409Y: 9dBi Radome enclosed directional antenna
A24-HG2405P-135: 5dBi Wi-Fi patch directional antenna

7.2 Battery

Every ZigSense node has an internal battery inserted by the system integrator or installer. The battery is used to operate the node when external power is not available. The batteries use Lithium technology

Battery specifications

ZigSense Model	Battery Model	Battery Technology	Battery Voltage	Battery Current
ZS24-REU-001	1 x AA	Lithium	3.6	2.4 A/h
ZS24-RRU-001	1 x AA	Lithium	3.6	2.4 A/h
ZS24-CGU-001	2 x AA	Lithium - rechargeable	7.2	2.4 A/h

7.3 GATEWAY COMMUNICATION CABLES

Communications cables are use mainly when interfacing the central gateway unit (CGU) to external control and SCADA systems

ZigSense Model	Cable Model	Communications Port	Comments	Protocol
ZS24-CGU-001	CA-RS485	Serial RS485	External RS485 Half Duplex	Modbus RTU
ZS24-CGU-001	CA-RS232	Serial RS232	External RS232	Modbus RTU
ZS24-CGU-001	CA-USB	USB	Local PC	ZigSense

ZigSense™

7.4 Sensors

Sensor can be ordered as accessories in addition to the ZigSense REU nodes

ZS-SNS-001: Temperature sensor.
Range: -50 to + 124.8 deg C. Output: 0 to 1VDC

ZS-SNS-002: Temperature sensor RTD Pt1000. Range: -44 to + 128 deg C

ZS-SNS-003: Temperature & % Relative Humidity external sensor
Rage: Temp: -50 to + 150. Output: 0 to 1VDC
Range: Relative Humidity: 0% to 100%. Output: 0 to 1VDC

8. SYSTEM SETUP AND CONFIGURATION

8.1 JOINING A NETWORK

During the process of creating a ZigSense network of wireless sensors nodes, each node must first be authenticated by the gateway prior to being authorized to join the network. Only authorized nodes will be able to communicate within the ZigSense wireless network and exchange data with the gateway

There are strict authentication rules that can be summarised as follows:

No Authentication → No Authorization → No Joining

During JOINING of the network process, authorized nodes are assigned a unique network ID known as the PANID plus a unique ZigSense network identification. The PANID is assigned by the network coordinator built into the central gateway unit (CGU)

To ensure network security, authentication of a new remote wireless unit (REU) is never automatic. New joining requires deliberate manual intervention by the system integrator. Once a wireless node has joined and was 'authorized' it will be permitted to communicate with the gateway through a ZigSense network that shares the same PANID and security arrangements

To ensure network security, each node credentials are automatically re-checked every time a node attempts to REJOIN the network

REJOINING attempts may occur if a node has lost its power or lost communications to the gateway. During the REJOINING attempt, if a node PANID is found to be different from the network's unique PANID it will be automatically rejected by the gateway and the node will not be permitted to join the network.

In such a situation the remote node will have to be manually RESET to factory default state by the system integrator and will have to repeat the standard joining process.

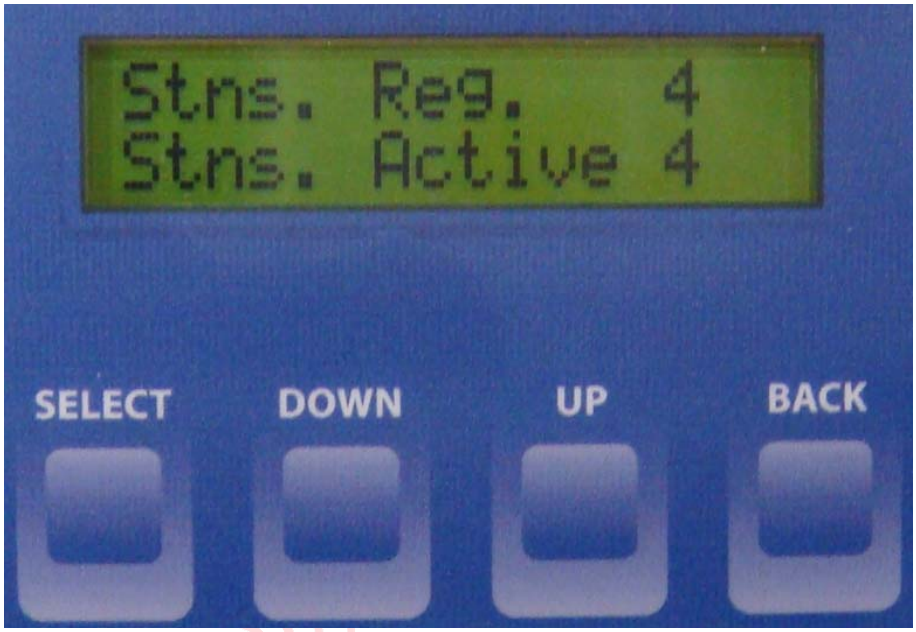
A ZigSense node keeps its allocated PANID and ZigSense ID even after power loss

A ZigSense node with an allocated PANID can be reset to its original factory settings by following specific 'master reset' instructions. Please see procedures on page 32

Third party ZigBee wireless nodes that do not conform to the ZigSense network authentication specifications will not be authorized to communicate with the gateway

8.2 CENTRAL GATEWAY UNIT (CGU) local HMI

The ZigSense gateway (CGU) includes a simple Human Machine Interface (HMI) in the form of a LCD display and four navigation buttons: SELECT + DOWN + UP + BACK



These buttons will assist the system integrator or installer to:

- View the number of authorized & joined stations (Registered)
- View the number of stations currently communicating (Active)
- View each station current authorization condition (ACTIVE / NOT ACTIVE)
- View communications indicator between gateway and external control systems
- View and modify the Gateway address on the Modbus network

An advanced way to add, delete, modify and monitor nodes on the ZigSense network is available by using **ZigSoft** - the ZigSense network software tool

ZigSoft model ZS-SWR-001 can run on any Windows based PC or laptop with screen resolution of 1024 x 768 pixels. ZigSoft is connected to the CGU via a standard USB cable For more information about ZigSoft please see chapter 10.0

8.3 GATEWAY COMMUNICATIONS PORTS

The gateway contains three communications ports

Port A: Wireless Port. This is the internal ZigSense wireless coordinator module.
It communicates to all remote nodes via an external antenna

Port B: Serial port. This is a 6 pins RS232 / RS485 port. It enables communications communicates to external control systems (PLC, SCADA etc) via Modbus RTU protocol.
The external systems exchanges data via the gateway's Holding registers listed in the ZigSoft Modbus Holding Registers map (see ZigSoft)

Default serial port settings: Modbus RTU, serial, 9600, N,8,1

Port C: A USB port interface between the gateway and a PC or laptop (Windows OS) running the ZigSoft software (see ZigSoft Chapter 10)

There is no need to run ZigSoft in order for the gateway to communicate with either the remote nodes or the external control systems via its Modbus RTU port

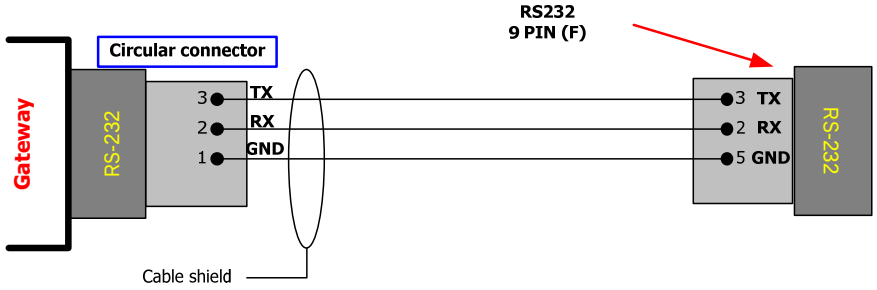
Gateways Rev.2: The power connector and battery switch are on the side panel

Battery ON/OFF switch controls an internal 7.2VDC Lithium rechargeable battery. The battery is used as the gateway backup power source during external power outage. Since the coordinator never sleeps, battery power usage time must be limited

Gateway **reset** button should only be used if you concluded that the gateway is not operating correctly. Push the Reset button momentarily. This action will not erase the internal nodes settings. **Observe the following:** The gateway LCD panel will go blank then display the previously **Registered nodes** and **Active nodes** will show 0 (due to the reset function). If any of the remote nodes is still running they will automatically attempt to perform a REJOIN function. Please wait till all nodes have rejoined the gateway.

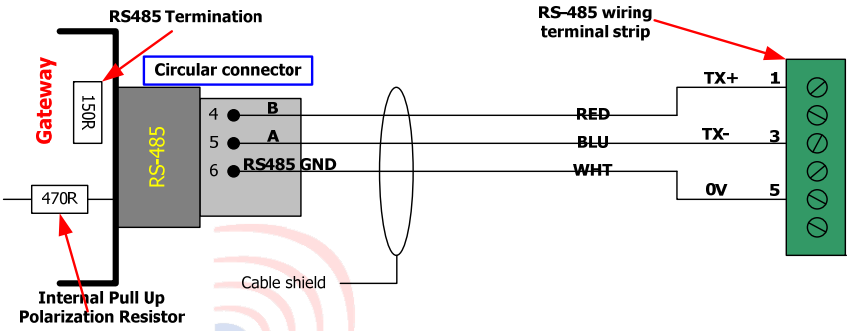
For a gateway factory reset function you must use ZigSoft. Factory reset will erase and clear the entire gateway current settings. You will then be required to perform a new JOIN function for all remote nodes

8.3.1 CABLE SERIAL INTERFACING - GATEWAY TO RS-232 PORT



A circular Serial port (6 pins) is used for either RS232 or RS485 serial communications

8.3.2 CABLE SERIAL INTERFACING - GATEWAY TO RS-485 PORT



RS485 Line Termination: A 150R resistor acting as a line terminator is built-in between pins 4 and 5 (wires A and B) of the gateway's Circular connector (RS-485 pins)

RS485 Line Polarization: If a Modbus device requires line polarization, one pair of resistors must be connected on the RS-485 balanced pair:

- A pull up resistor to a 5V on A+ circuit
- A pull down resistor to 0V on B- circuit

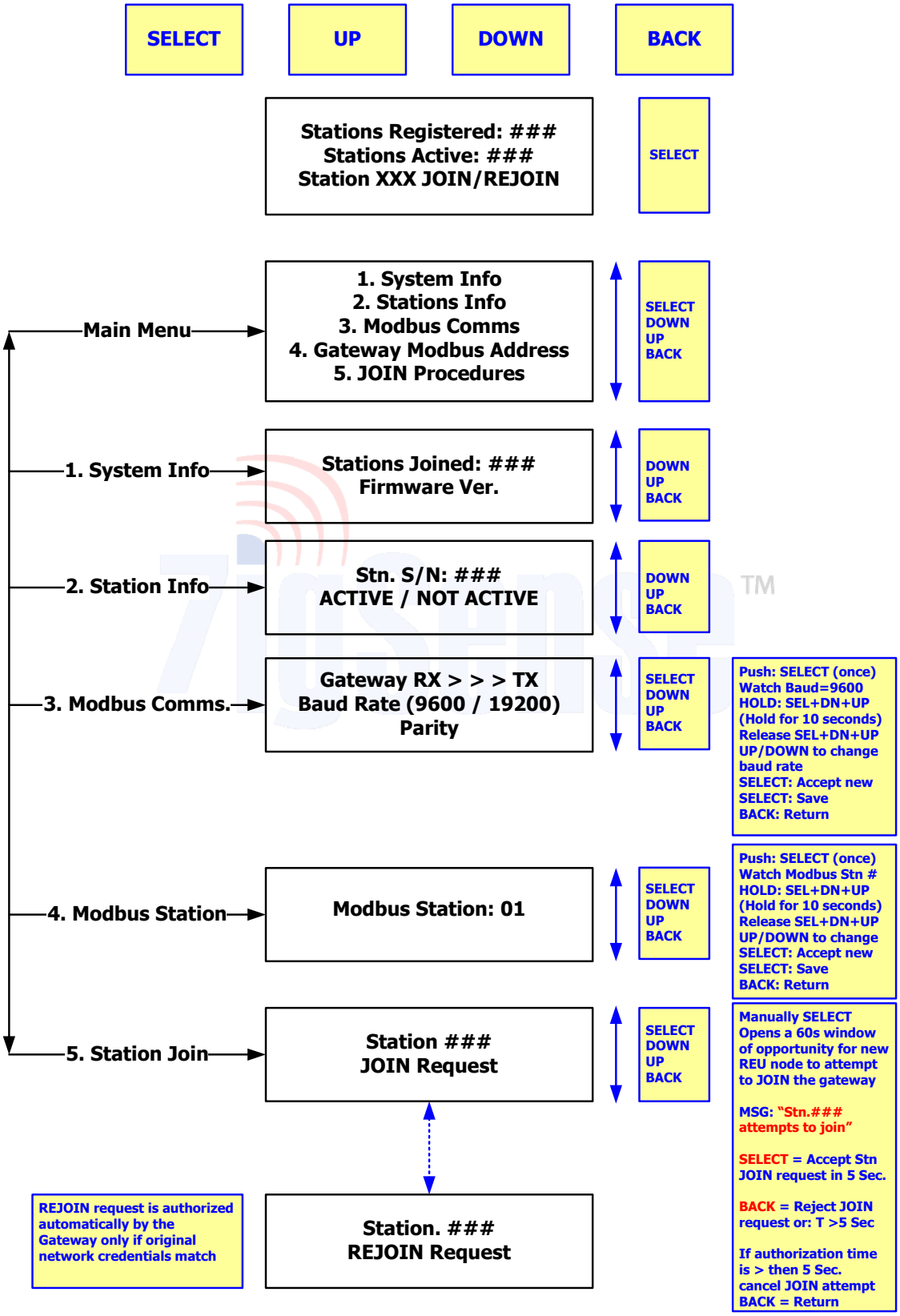
The polarization must be implemented at one location only. The line polarization point is normally selected close to the MASETR device (i.e. PLC port, SCADA port). Other devices should not implement any line polarization

8.3.3 ZS24-ISC-1112-I EXTERNAL RS232 to RS485 converter

Model **ZS24-ISC-1112-I** is ZigSense external RS232 to RS485/RS422 converter. It includes 3000V isolation between the ports. Please contact the supplier for a price quotation

8.4 ZIGSENSE GATEWAY HMI MENU

Basic menu selections can be manipulated using the LCD screen and keypad. It is generally recommended to use ZigSoft for a faster and simpler menu selection activity

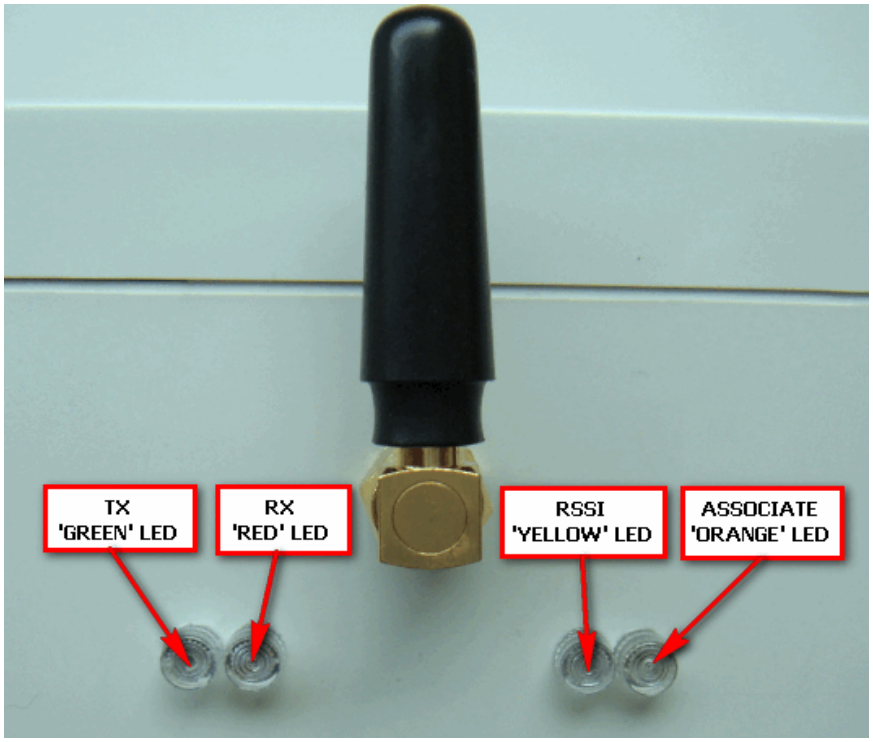


8.5 WIRELESS NODES - COMMUNICATIONS INDICATORS

ZigSense nodes include four (4) LED indicators installed to the right and to the left of the communications antenna. These LEDs provide the user with a general visual indication regarding the 'HEALTH' of the wireless network

8.5.1 REMOTE END UNIT (REU) LED INDICATORS FLASH ACTIVITY

1. When powered by external power supply – Flash activity every 5 seconds
2. When powered by internal backup battery power – Flash activity every 30 seconds



ASSOCIATE (ORANGE) Quick flash, indicating that an active node is associated with the existing network (this is a standard ZigBee node signal)

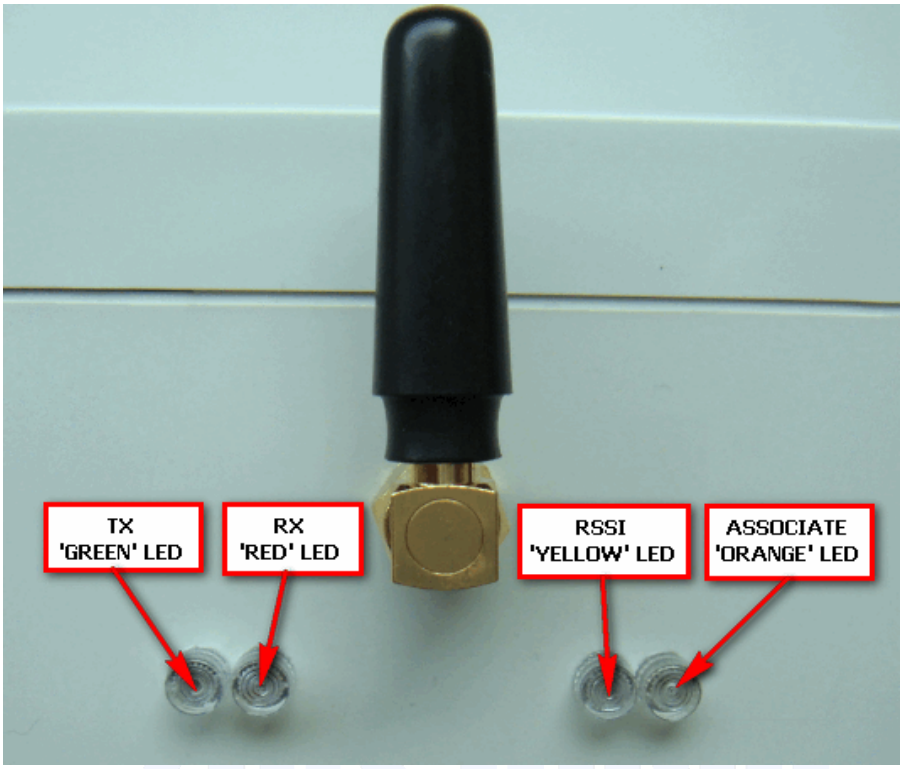
RSSI (YELLOW) Quick flash, indicating RF signal detected (during RF communications)

RX (RED) Quick flash, indicating data received OK.
If RED LED is ON continuously it indicates an error in communications

TX (GREEN) Quick flash, indicating data transmitted OK.

8.5.2 ROUTER (RRU) LED INDICATORS FLASH ACTIVITY

1. Under external power supply – Flash activity every 5 seconds
2. Under backup battery power – Flash activity every 30 seconds



Associate (ORANGE) + TX (GREEN) – Both flash alternately during normal operation

RSSI (YELLOW) – **Wireless network is functioning**
Flash ON (beacons) once every 5 minutes (approx)
Flash ON (beacons) when TEST button is pushed and then released (inside the RRU)

ASSOCIATE (ORANGE) –Wireless network is NOT functioning
ORANGE + **GREEN** LEDs will continue to flash as per normal for a period of 15 minutes. If the wireless network is still faulty after 15 minutes the **ORANGE** LED will stay **ON** continuously and the **GREEN** LED will turn itself **OFF**

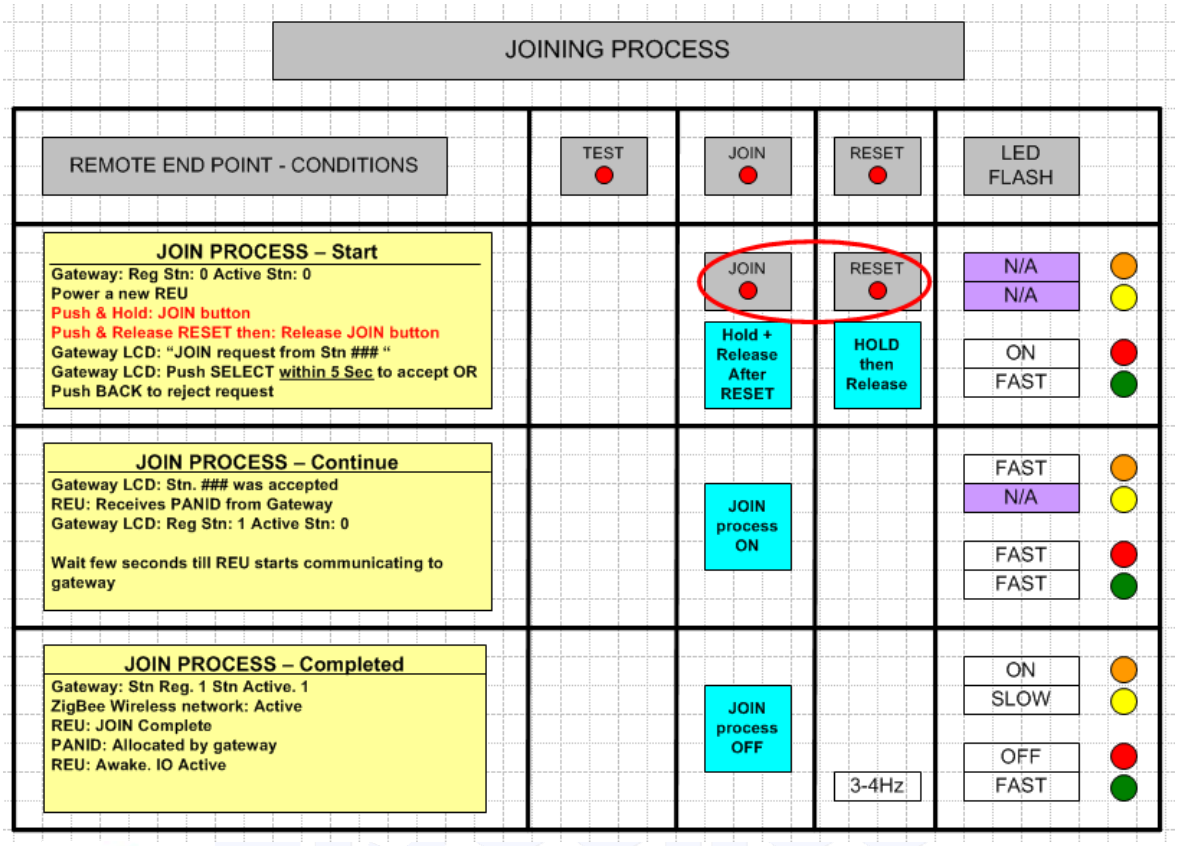
RX RED LED - Normally OFF. RED is **ON** whenever the TEST button is pushed and released. This indicates that the internal micro-processor of the router (RRU) is functioning correctly

What to do if the wireless network between RRU and CGU was lost?
Push and Release the TEST button inside the RRU – Watch RED LED is ON
Push and Release the TEST button again – Watch the YELLOW LED coming ON and then observe normal ORANGE + GREEN flashing activity

8.6 ADDING A NEW WIRELESS NODE –NEW JOIN INSTRUCTIONS

Any new wireless node such as a Remote End Unit (REU) or a Remote Router Unit (RRU) must first be authorized by the gateway (CGU) prior to JOINING the ZigSense network.

IF A NODE HAS ALREADY JOINED - DO NOT TAKE THE FOLLOWING STEPS



A NEW JOIN request must be **manually authorized** by the system integrator The gateway LCD display must be observed during NEW JOIN procedures.

Press the **SELECT** button within 5 seconds from viewing the message:
'JOIN request from station XXX' (or 'JOIN request from Router')

The JOIN request will be rejected by the gateway if the **SELECT** button was not pushed to AUTHORIZE the requesting node within the 5 seconds window of opportunity

If a new REU has not succeeded in JOINING as described above, do the following:

1. Manually scroll down to step 5 of LCD. When you push the SELECT button a pre-defined 60 seconds JOIN window of opportunity will start
2. Remove power supply from REU. Push & Hold the JOIN button. Power-up REU while holding JOIN button wait till Associate LED is ON – release the JOIN button and authorise the request by using the SELECT button (see description above)

A node that was previously authenticated and authorized to join the gateway, will automatically attempt to **REJOIN** the gateway during power-up. During a REJOIN process the gateway automatically re-authenticates the node credentials

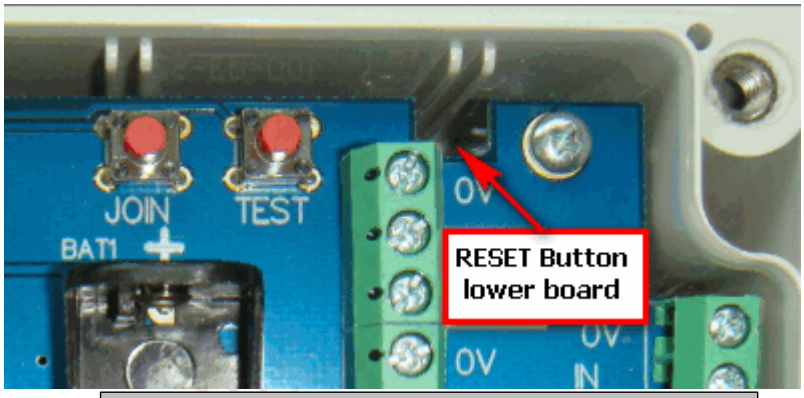
REJOINING ATTEMPT IS ALWAYS DONE AUTOMATICALLY

8.6.1 PERFORMING FACTORY MASTER RESET for REMOTE NODES

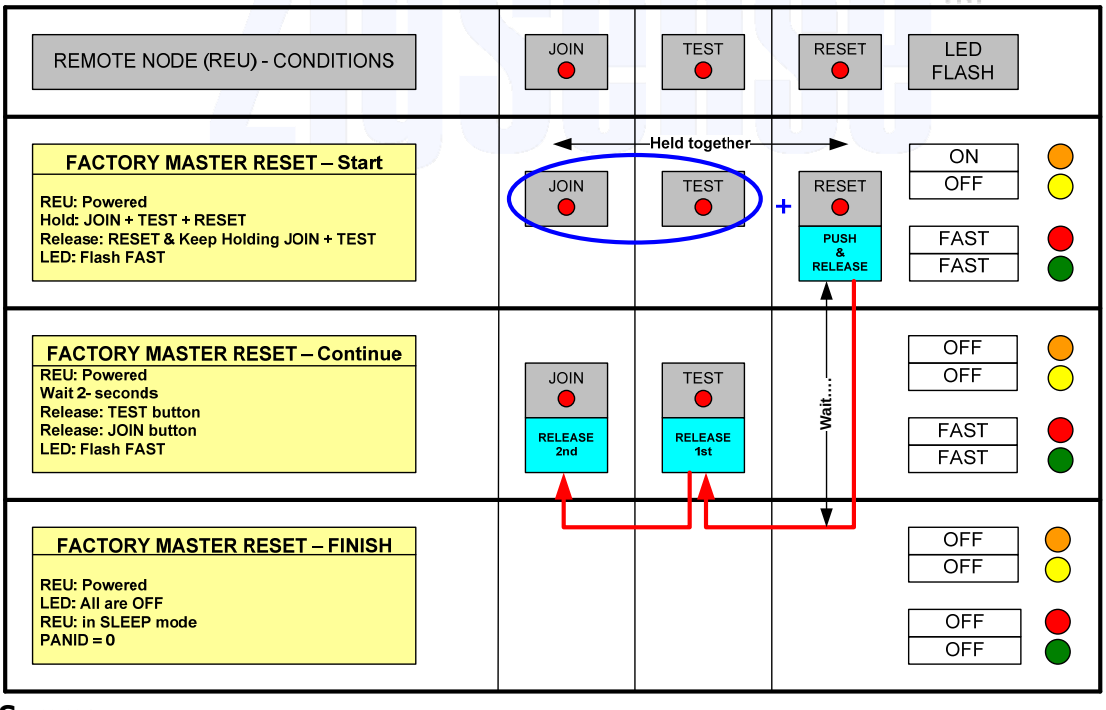
A newly manufactured REU is set by default to **FACTORY MASTER RESET** conditions where its internal network ID (PANID) is set to = 0

A fully operational REU can be set to FACTORY RESET conditions by a system integrator. FACTORY RESET should only be attempted by a technical person familiar with these procedures. FACTORY RESET requires the simultaneous use of three buttons: **JOIN + TEST + RESET** as shown in the table below

FACTORY RESET was deliberately made difficult. It may take several attempts to achieve the RESET stage. The RESET button can be accessed as shown here:



FACTORY MASTER RESET - REU



Summary:

1. Push and Hold all three buttons JOIN + TEST + RESET

2. Release the RESET button while still holding JOIN + TEST. The Orange LED will be ON for a short period. Then the RED + GREEN LED will start to flash (after a short delay)

3. Then release the TEST button followed by

4. Release the JOIN button. The LEDs will keep flashing for a while then all LED will turn OFF. When all LED are OFF the REU achieved FACTORY RESET. PANID = 0. The REU in SLEEP

9. SLEEP-WAKE CYCLE

9.1 REU SLEEP-WAKE CYCLE – TYPICAL OPERATION

The ZigSense remote IO nodes are designed as low power nodes. A remote end unit (REU) is typically powered by an external DC voltage power supply (12VDC Max) and an internal backup battery.

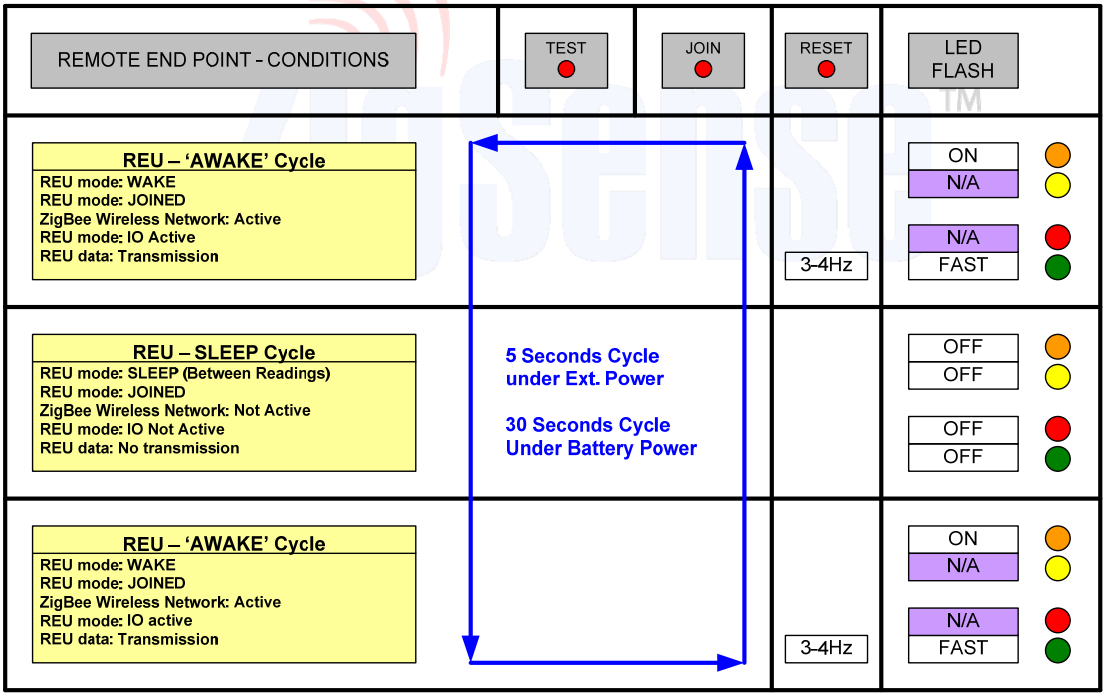
The REU contains a single AA 3.6VDC Lithium battery enabling it to be powered and transfer data when external power is not available

ZigSense remote end units (REU) scan and exchange data with the gateway in two modes:

- **Under External Power Supply:**
  REU scans sensors & transfer data to gateway **every 5 seconds (default)**

- **Under Internal Battery Power:**
  REU scan sensors & transfer data to gateway **every 30 seconds (default)**

The default SLEEP-WAKE cycle time cam be modified



10. ZIGSOFT ™ – SOFTWARE FOR ZIGSENSE SYSTEMS

The ZigSense gateway overall settings can be generally viewed by the operator scrolling through the LCD HMI display. The operator HMI panel (discussed in chapter 8.2) will only provide the operator with limited information regarding the remote wireless stations.

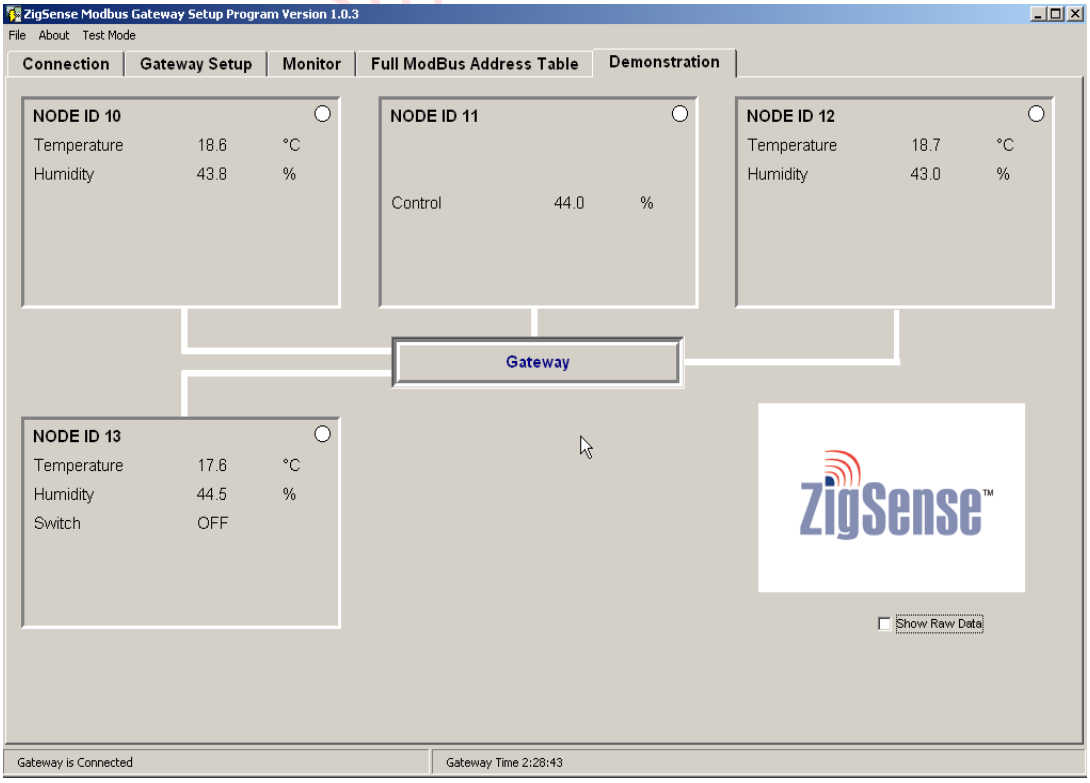
For more advanced information regarding the gateway, remote stations and the overall network operations, we recommend the use of ZigSoft™ software package

10.1 SOFTWARE & HARDWARE INTERFACE

The gateway's built-in Modbus RTU serial port provides system integrators with RS232/RS485 communications interface to other control and SCADA systems. One of the more common requirements is to interface the gateway to external HMI operators' panels or SCADA software packages.

Data from REU stations is available in the gateway's **Holding Registers** (Modbus RTU) memory area. Your own HMI or SCADA graphical software application may look different

The below screen capture is a sample only of graphical HMI displaying data sent from four ZigSense REU nodes. ZigSoft software was designed for general monitoring and maintenance purposes of ZigSense network. ZigSoft does not contain graphical drawing tools therefore it can not generate graphical screens.



10.2 INSTALLATION OF ZIGSOFT SOFTWARE

10.2.1 INSTALLING ZIGSOFT FROM A CD

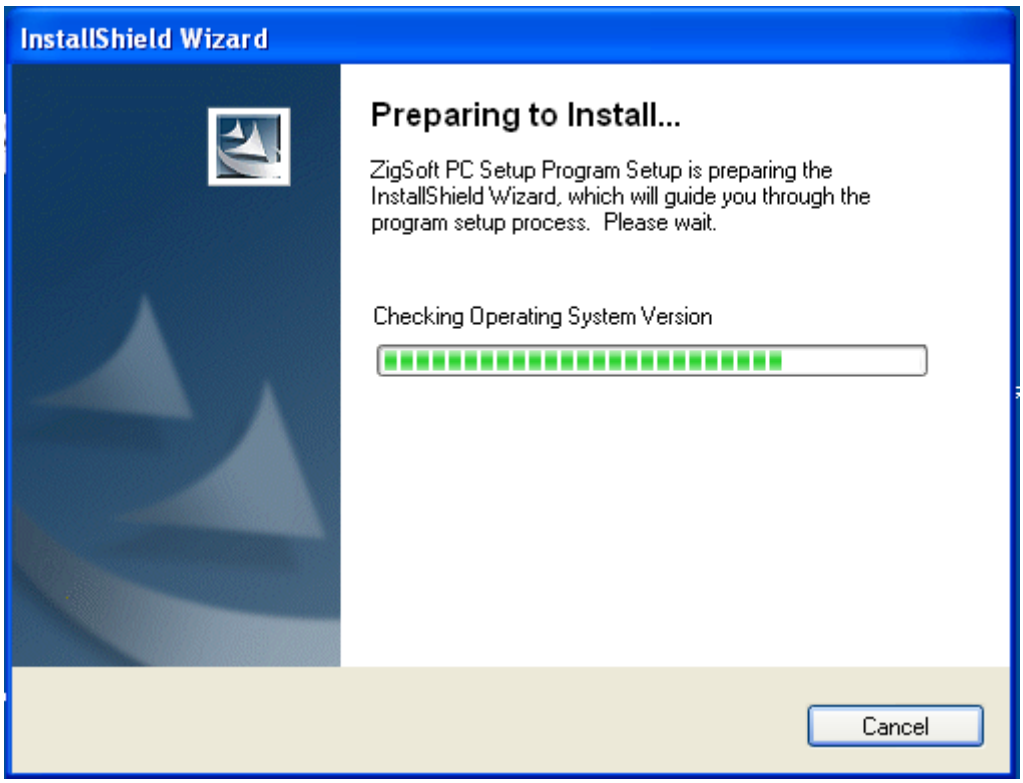
Insert the CD. If setup does not start automatically, start Windows Explorer, browse to the CD drive. Double-click left mouse button on setup.exe.

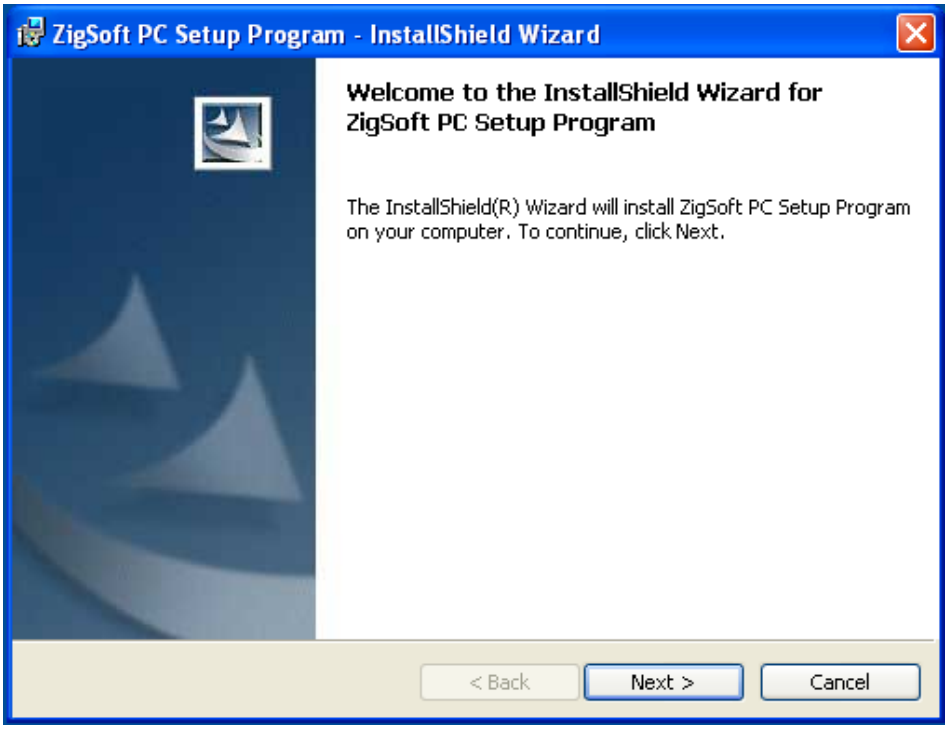
If installing ZigSoft downloaded from a web site:

Save the file zigsoftsetup.exe to your hard disk. Start Windows Explorer, browse to the folder. Double-click left mouse button on zigsoftsetup.exe.

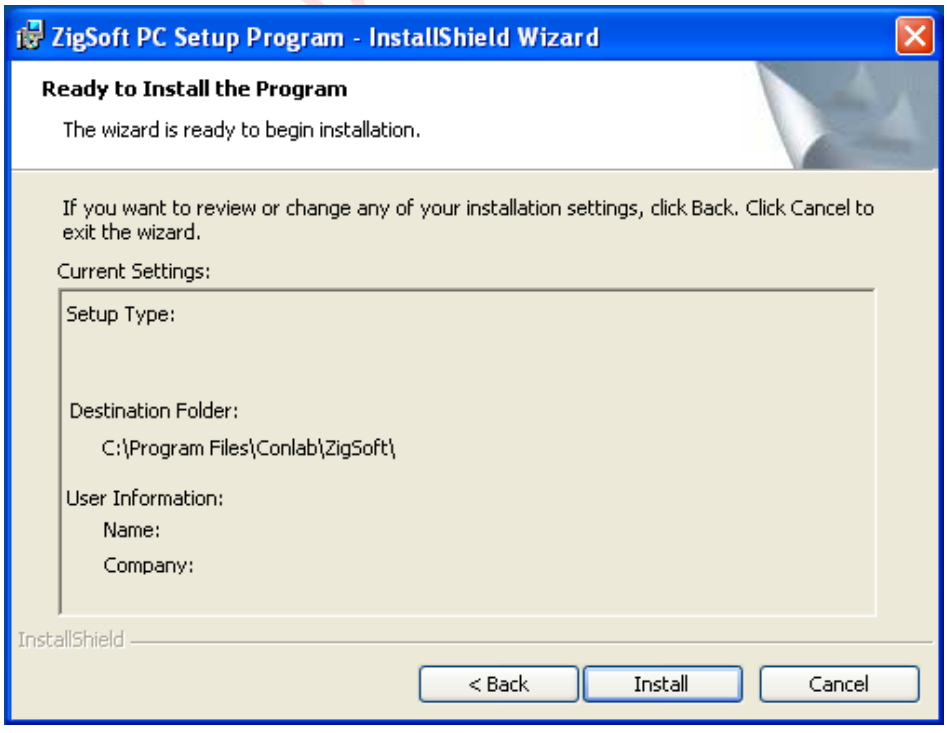
DO NOT CONNECT THE USB CABLE TO THE ZIGSENSE GATEWAY UNTIL AFTER THE USB DRIVER HAS BEEN INSTALLED

The Installation program will start with the following screen:

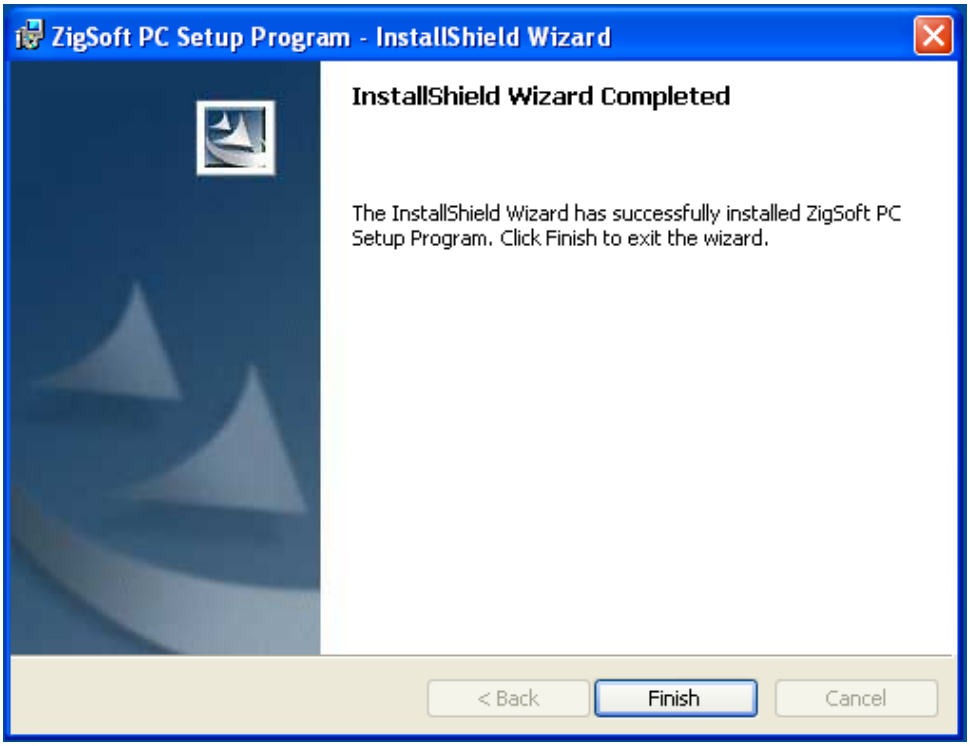

InstallShield Wizard
Preparing to Install...
ZigSoft PC Setup Program Setup is preparing the InstallShield Wizard, which will guide you through the program setup process. Please wait.
Checking Operating System Version
Cancel


ZigSoft PC Setup Program - InstallShield Wizard
Welcome to the InstallShield Wizard for ZigSoft PC Setup Program
The InstallShield(R) Wizard will install ZigSoft PC Setup Program on your computer. To continue, click Next.
< Back
Next >
Cancel

Click the **Next** button.



Click the **Install** button.

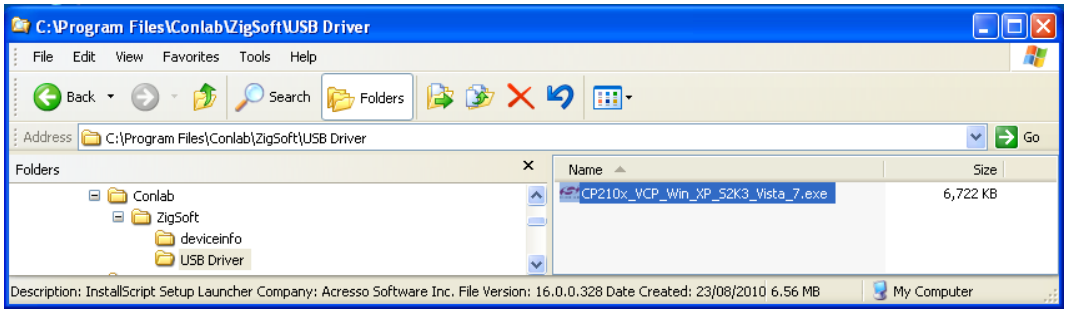

ZigSoft PC Setup Program - InstallShield Wizard
InstallShield Wizard Completed
The InstallShield Wizard has successfully installed ZigSoft PC Setup Program. Click Finish to exit the wizard.
< Back
Finish
Cancel

Click the **Finish** button.

10.2.2 INSTALLATION OF USB DRIVERS

DO NOT CONNECT THE USB CABLE TO THE ZIGSENSE GATEWAY UNTIL AFTER THE USB DRIVER HAS BEEN INSTALLED

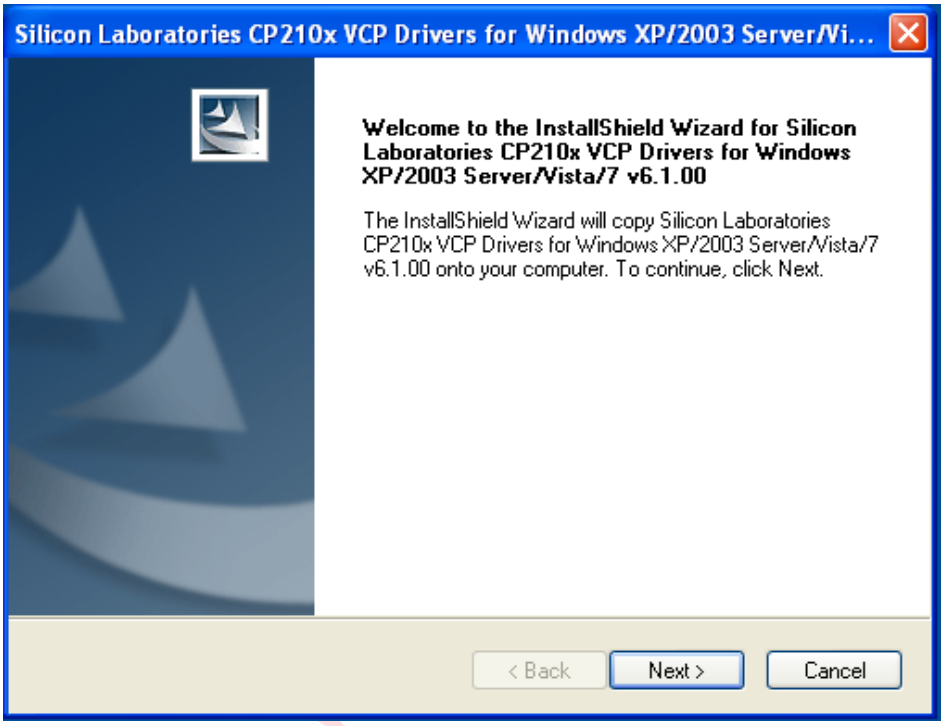
Start Windows Explorer, browse to the folder "C:\Program Files\Conlab\ZigSoft\USB Driver".



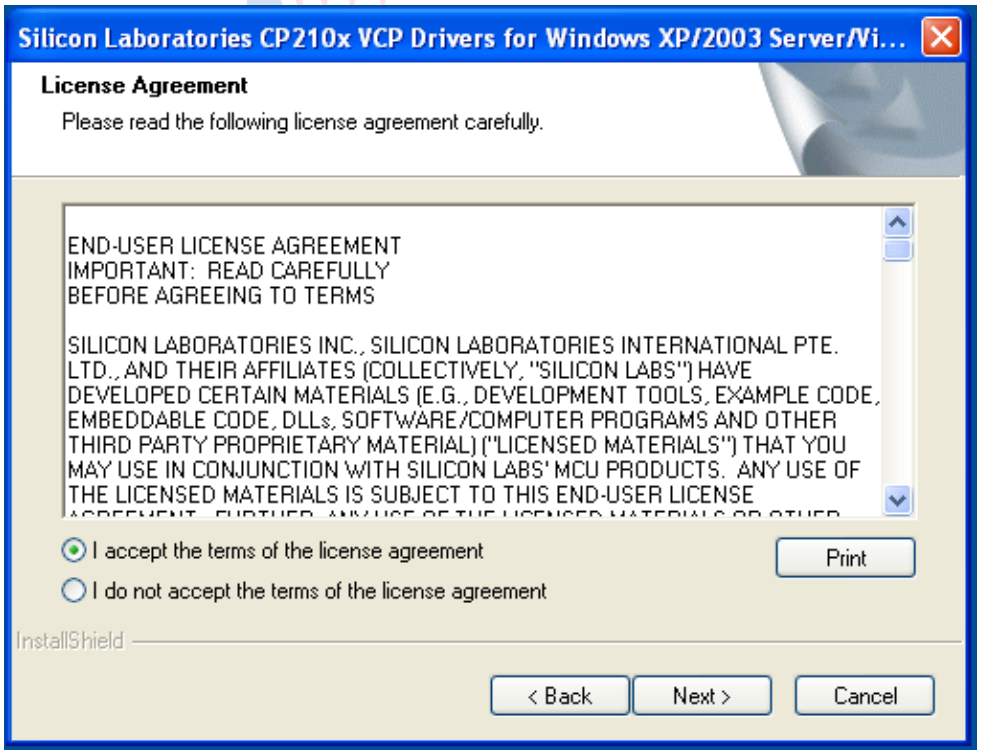
To start the USB driver installation, double-click left mouse button on the file "CP210x_VCP_Win_XP_S2K3_Vista_7.exe".

If the USB drivers have already been installed, you will see a screen with the message “Existing Installed Instances Detected”. Unless you wish to reinstall or upgrade the USB drivers, click the **Cancel** button to exit the driver installation procedure. For instructions on reinstalling/upgrading the USB driver, see Section 5, “Reinstalling and upgrading the USB drivers”.

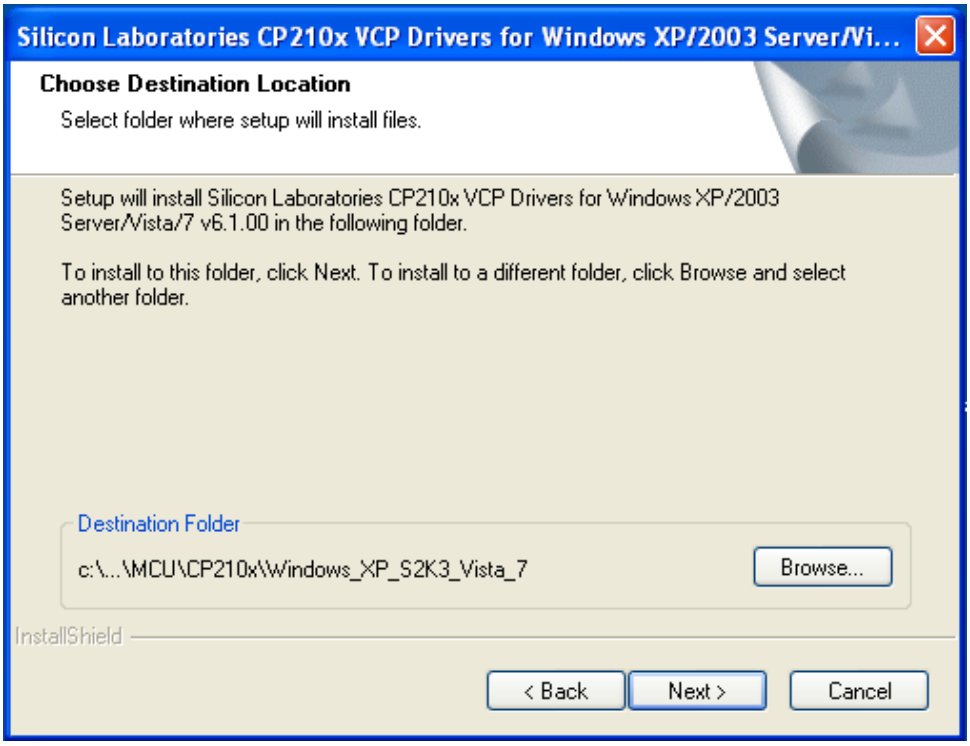
For a new driver installation, the following screen will be displayed:


Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vi...
Welcome to the InstallShield Wizard for Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vista/7 v6.1.00
The InstallShield Wizard will copy Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vista/7 v6.1.00 onto your computer. To continue, click Next.
< Back
Next >
Cancel

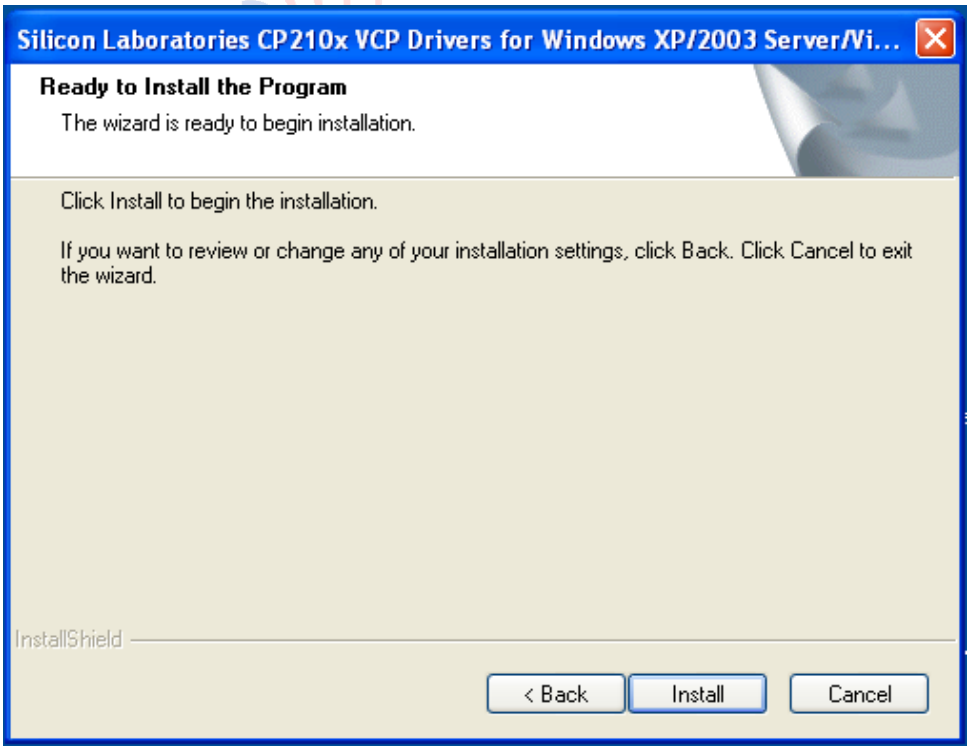
Click the **Next** button.


Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vi...
License Agreement
Please read the following license agreement carefully.
END-USER LICENSE AGREEMENT
IMPORTANT: READ CAREFULLY
BEFORE AGREEING TO TERMS
SILICON LABORATORIES INC., SILICON LABORATORIES INTERNATIONAL PTE. LTD., AND THEIR AFFILIATES (COLLECTIVELY, "SILICON LABS") HAVE DEVELOPED CERTAIN MATERIALS (E.G., DEVELOPMENT TOOLS, EXAMPLE CODE, EMBEDDABLE CODE, DLLs, SOFTWARE/COMPUTER PROGRAMS AND OTHER THIRD PARTY PROPRIETARY MATERIAL) ("LICENSED MATERIALS") THAT YOU MAY USE IN CONJUNCTION WITH SILICON LABS' MCU PRODUCTS. ANY USE OF THE LICENSED MATERIALS IS SUBJECT TO THIS END-USER LICENSE
I accept the terms of the license agreement
I do not accept the terms of the license agreement
Print
InstallShield
< Back
Next >
Cancel

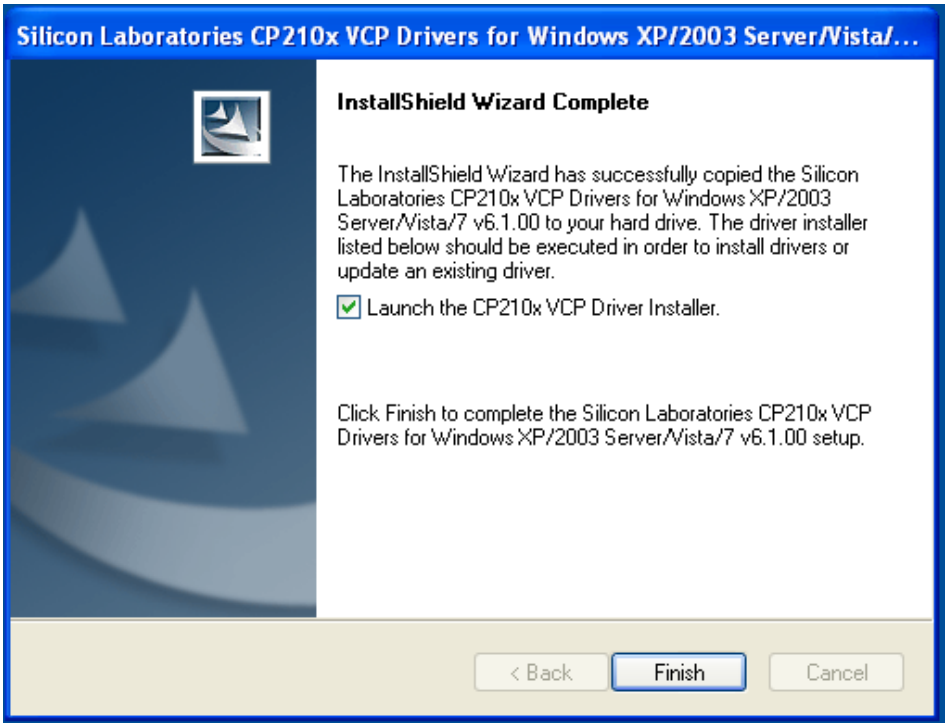
Select "**I accept the terms of the license agreement**". Click the **Next** button.


Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vi...
Choose Destination Location
Select folder where setup will install files.
Setup will install Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vista/7 v6.1.00 in the following folder.
To install to this folder, click Next. To install to a different folder, click Browse and select another folder.
Destination Folder
c:\...\MCU\CP210x\Windows_XP_S2K3_Vista_7
Browse...
InstallShield
< Back
Next >
Cancel

Do **not** change the Destination Folder.
Click the **Next** button.


Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vi...
Ready to Install the Program
The wizard is ready to begin installation.
Click Install to begin the installation.
If you want to review or change any of your installation settings, click Back. Click Cancel to exit the wizard.
InstallShield
< Back
Install
Cancel

Click the **Install** button.


Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vista/...
InstallShield Wizard Complete
The InstallShield Wizard has successfully copied the Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vista/7 v6.1.00 to your hard drive. The driver installer listed below should be executed in order to install drivers or update an existing driver.
Launch the CP210x VCP Driver Installer.
Click Finish to complete the Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vista/7 v6.1.00 setup.
< Back
Finish
Cancel

You have now completed the first part of the USB driver installation procedure.
The USB driver files have been installed (copied) to a folder on the local hard disk.

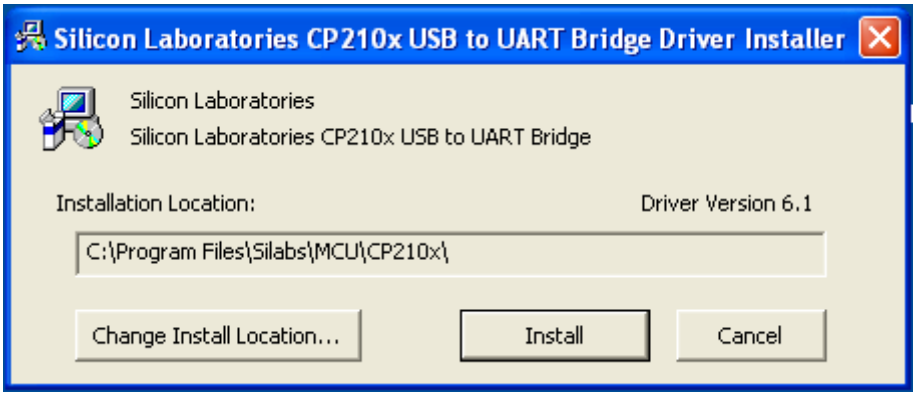
At the end of the first part of the driver installation, you will see a tick box "**Launch the CP210x VCP Driver Installer**".

DO NOT UNTICK THE BOX "LAUNCH THE CP210X VCP DRIVER INSTALLER" AS THIS WILL CAUSE THE DRIVER INSTALLATION PROCEDURE TO FAIL.

DO NOT CLICK THE CANCEL BUTTON. THIS WILL ALSO CAUSE THE DRIVER INSTALLATION PROCEDURE TO FAIL.

Click the **Finish** button.

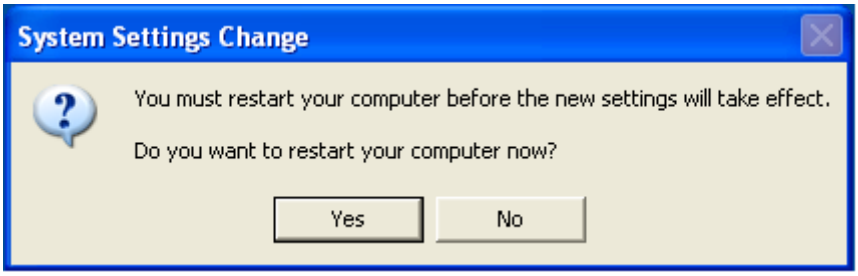
The second part of the USB driver installation procedure will now start.



The above dialog will show the Installation Location. Do **not** change the Install Location.

Click the **Install** button. A message will be displayed on the screen “Scanning computer”. This may take 1-2 minutes. The screen will then indicate that the USB driver files are being installed.

Wait for the installation to finish. Once the installation has completed, you will be asked to restart the computer. You **must** restart the computer at this point.

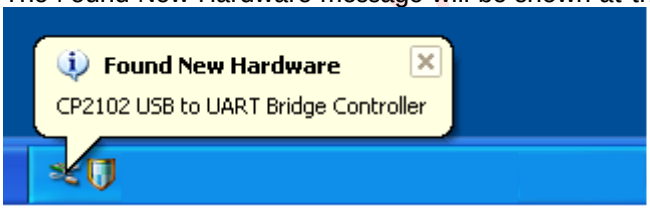

System Settings Change
You must restart your computer before the new settings will take effect.
Do you want to restart your computer now?
Yes
No

10.2.3. CONNECTION OF USB CABLE TO ZIGSENSE GATEWAY

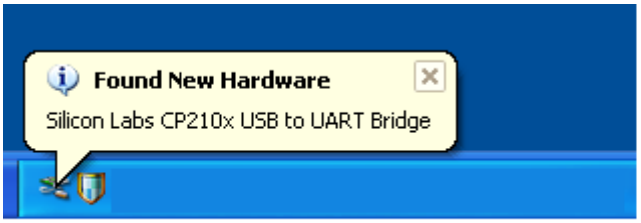
Plug in the Power cable to the Gateway.

Plug the USB cable in to the Gateway USB connector and then plug the USB cable in to a USB port on your computer.

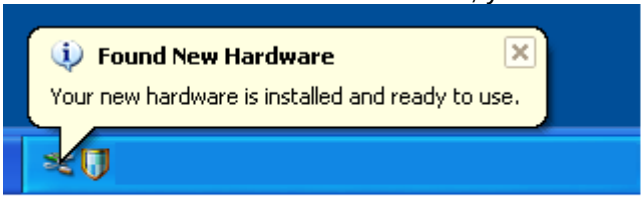
The Found New Hardware message will be shown at the lower RH corner of the screen.



After a short delay, the message will change:



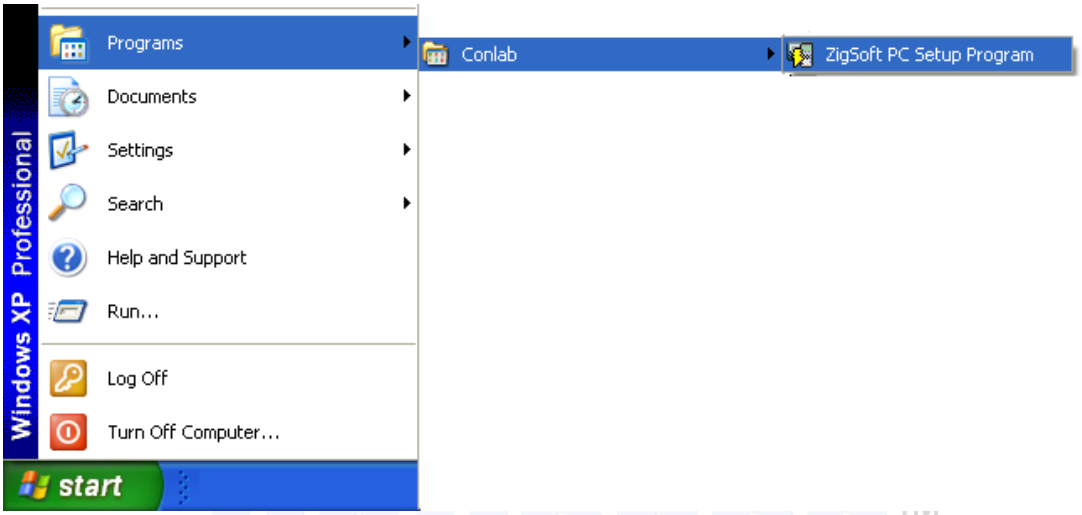
Once the USB device has been installed, you will see the following message:



10.2.4 STARTING ZIGSOFT PC SETUP PROGRAM

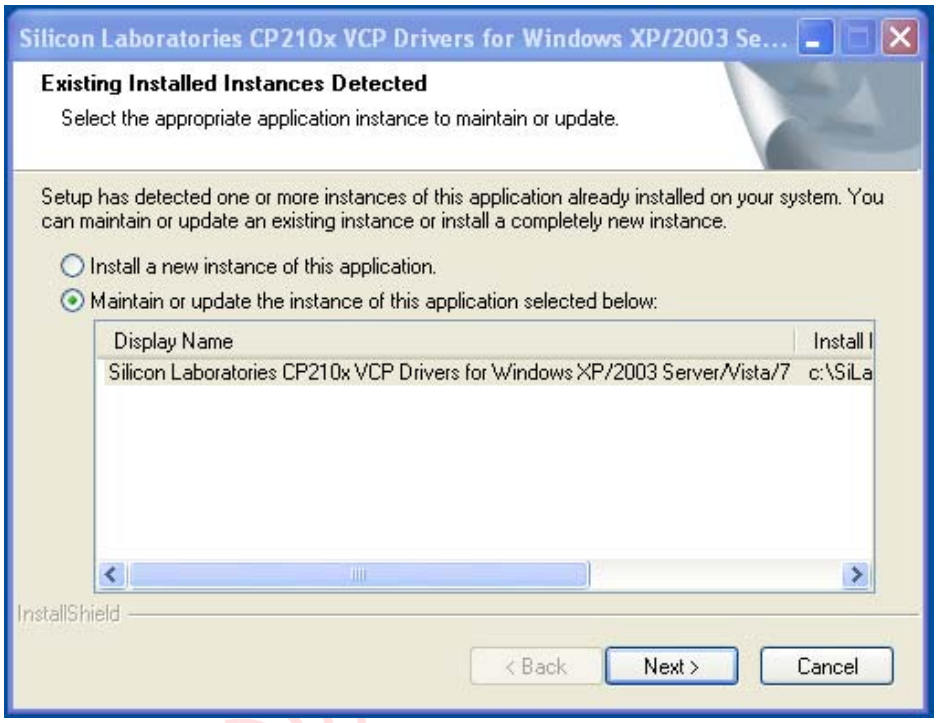
The ZigSoft Program may be started via the Desktop icon:

or via the Windows Start menu:

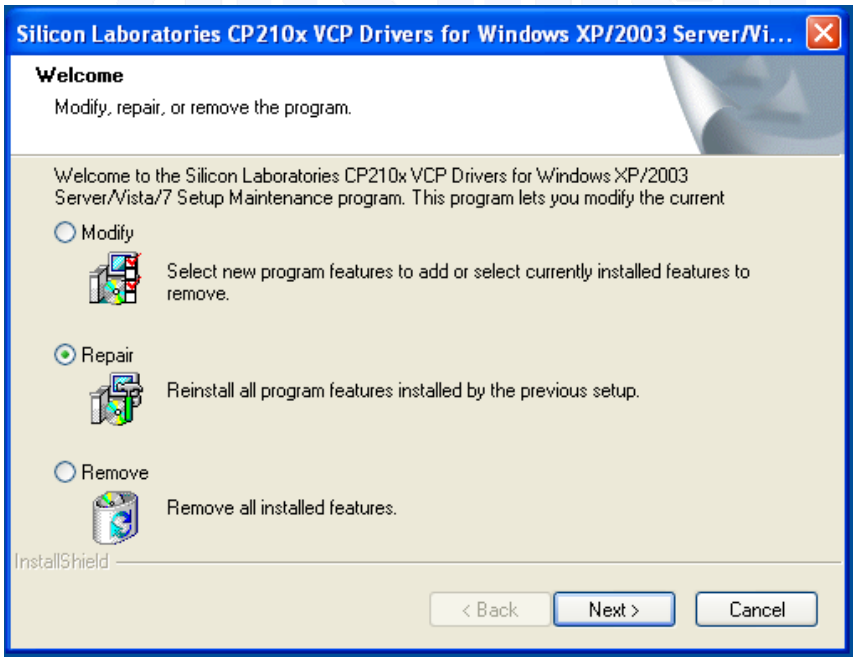


10.2.5 REINSTALLING AND UPGRADING THE USB DRIVERS.

When you start the USB driver installer, the following screen will be displayed:


Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Se...
Existing Installed Instances Detected
Select the appropriate application instance to maintain or update.
Setup has detected one or more instances of this application already installed on your system. You can maintain or update an existing instance or install a completely new instance.
Install a new instance of this application.
Maintain or update the instance of this application selected below:
Display Name
Install l
Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vista/7
c:\SiLa
InstallShield
< Back
Next >
Cancel

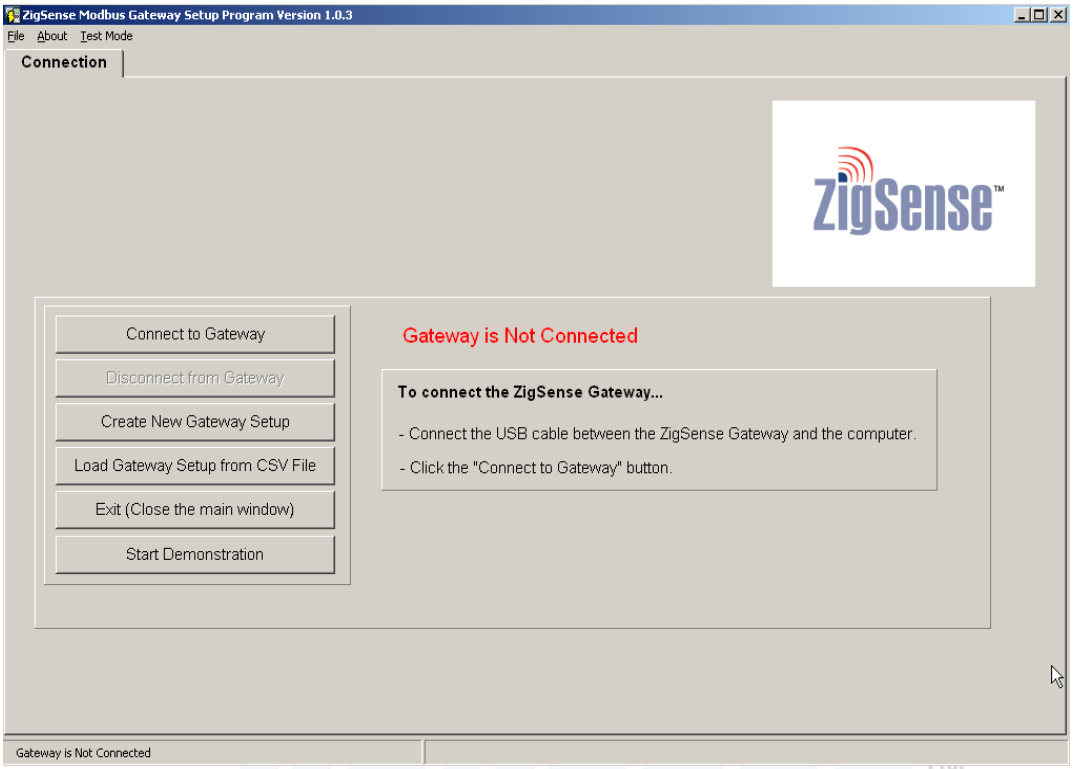
To reinstall the driver, or to upgrade the USB driver, select “Maintain or update the instance of this application selected below” and click the **Next** button.


Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vi...
Welcome
Modify, repair, or remove the program.
Welcome to the Silicon Laboratories CP210x VCP Drivers for Windows XP/2003 Server/Vista/7 Setup Maintenance program. This program lets you modify the current
Modify
Select new program features to add or select currently installed features to remove.
Repair
Reinstall all program features installed by the previous setup.
Remove
Remove all installed features.
InstallShield
< Back
Next >
Cancel

Select “Repair”. Click the **Next** button. The driver installation procedure will continue as described in Section 10.2.2: Installation of USB Drivers.

10.3 GATEWAY CONNECTION TAB

When ZigSoft starts you will see the following screen


ZigSense Modbus Gateway Setup Program Version 1.0.3
File About Test Mode
Connection
ZigSense
Connect to Gateway
Disconnect from Gateway
Create New Gateway Setup
Load Gateway Setup from CSV File
Exit (Close the main window)
Start Demonstration
Gateway is Not Connected
To connect the ZigSense Gateway...
- Connect the USB cable between the ZigSense Gateway and the computer.
- Click the "Connect to Gateway" button.
Gateway is Not Connected

Click on the **Connect to Gateway** button
Wait for the message: **Gateway is Connected**

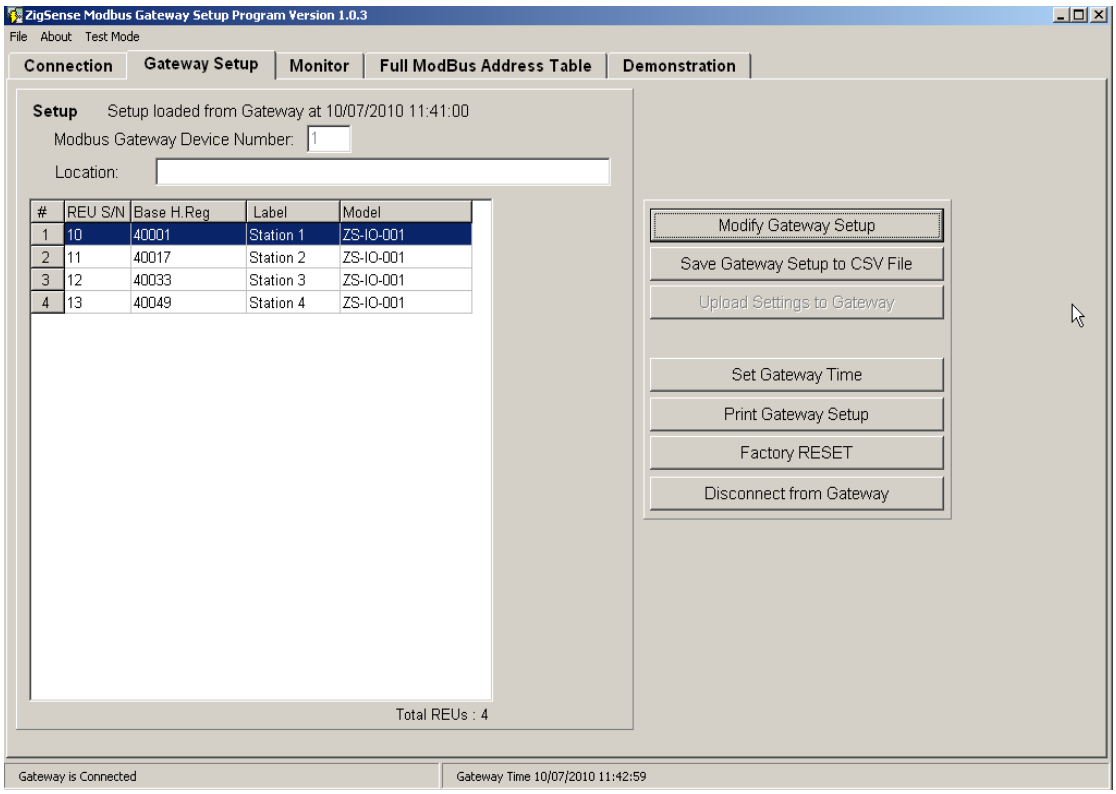
Once a gateway is connected you select from the following options:

- Disconnect from the Gateway
- Exit (close the main ZigSoft window)
- Start demonstration (if this option is available)

10.4 GATEWAY SET-UP TAB

Once a central gateway unit (CGU) is connected to your PC it will automatically open up the gateway set-up table. This table can also be viewed by selecting the Gateway Set-up tab

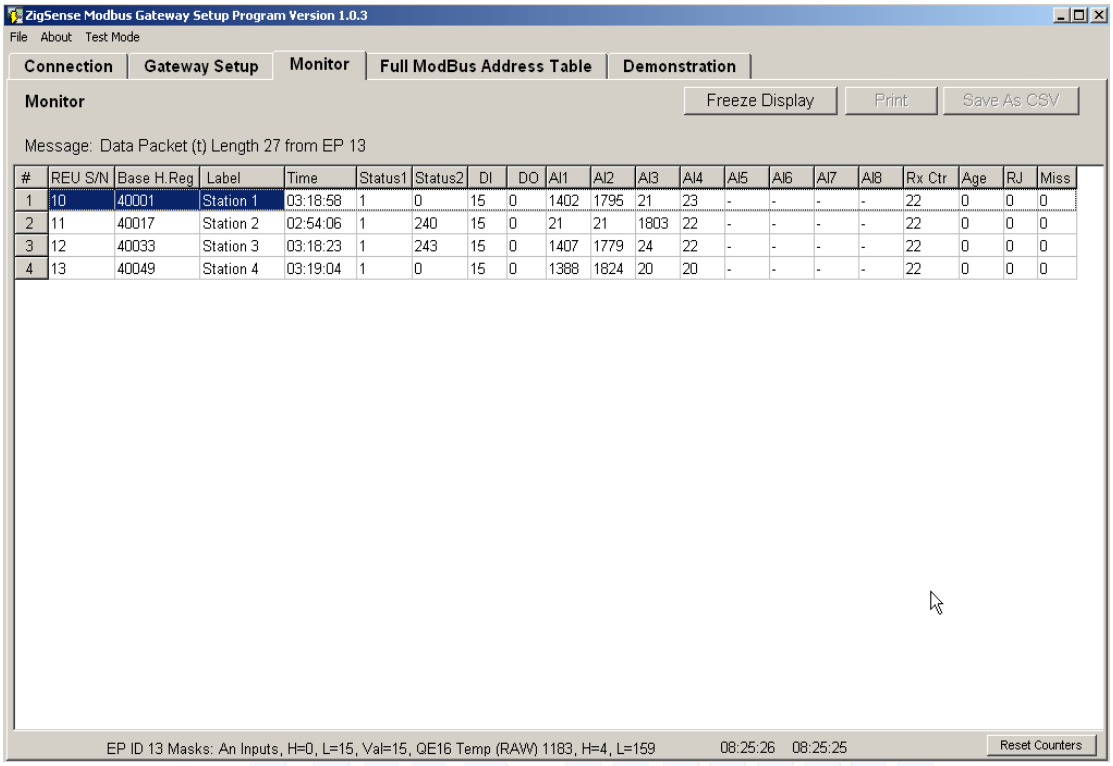
If the gateway has already been through the process of authorising ZigSense remote end units (see JOIN procedures) the REU nodes will be listed in the order they have joined the gateway. Since the JONING process can be done in any order it would be possible to view the REU S/N in a non sequential list such as: 10, 27, 131, 12, etc. The REU serial number (S/N) cannot be modified



Should you wish to re-define the order in which the REU nodes are listed in the gateway set-up table, you will need to manually enter the REU information or alternatively export the gateway set-up to a CSV file, modify the order then upload the CSV file back to the gateway

10.5 THE MONITOR TAB

Select the **Monitor** tab to view the Monitor table. If REU stations have already joined the CGU and if the ZigSense network is active, real data sent from the REU stations will now be displayed in a table format as shown below:



#	REU S/N	Base H.Reg	Label	Time	Status1	Status2	DI	DO	AI1	AI2	AI3	AI4	AI5	AI6	AI7	AI8	Rx Ctr	Age	RJ	Miss
1	10	40001	Station 1	03:18:58	1	0	15	0	1402	1795	21	23	-	-	-	-	22	0	0	0
2	11	40017	Station 2	02:54:06	1	240	15	0	21	21	1803	22	-	-	-	-	22	0	0	0
3	12	40033	Station 3	03:18:23	1	243	15	0	1407	1779	24	22	-	-	-	-	22	0	0	0
4	13	40049	Station 4	03:19:04	1	0	15	0	1388	1824	20	20	-	-	-	-	22	0	0	0

REU S/N – The REU unique serial number
Base H. Reg – The first Holding Register address associated with each REU
Label –Text identifying the REU by name or its location
Time – Time period from the first instance the CGU received a message from the REU
Status 1 – Displays REU fault conditions as a decimal number (8 bit binary form)
Status 2 – Displays REU general status conditions as a decimal number (8 binary form)
DI – Displays digital inputs conditions. e.g.: All DI are not activated. 15 = F (HEX) i.e. 1111
DO – Displays digital outputs conditions. e.g.: All DO are not activated. 0 = 0 (HEX) i.e. 0000
AI1 – Displays raw data of analogue input 1
AI2 – Displays raw data of analogue input 2
AI3 – Displays raw data of analogue input 3
AI4 – Displays raw data of analogue input 4
CI1 – Displays data of pulse counter 1. Counter 1 is associated with digital Input 1
CI2 – Displays data of pulse counter 1. Counter 1 is associated with digital Input 1
CI3 – Displays data of pulse counter 1. Counter 1 is associated with digital Input 1
CI4 – Displays data of pulse counter 1. Counter 1 is associated with digital Input 1
Rx Ctr – Counts the number of times data packets have arrived from the specific REU
Age –Displays the time passed from the previous message during a communication loss
RJ – Displays the total number of node REJOINING after communications were lost
Miss – Displays the total number of communications packets lost between the REU and CGU

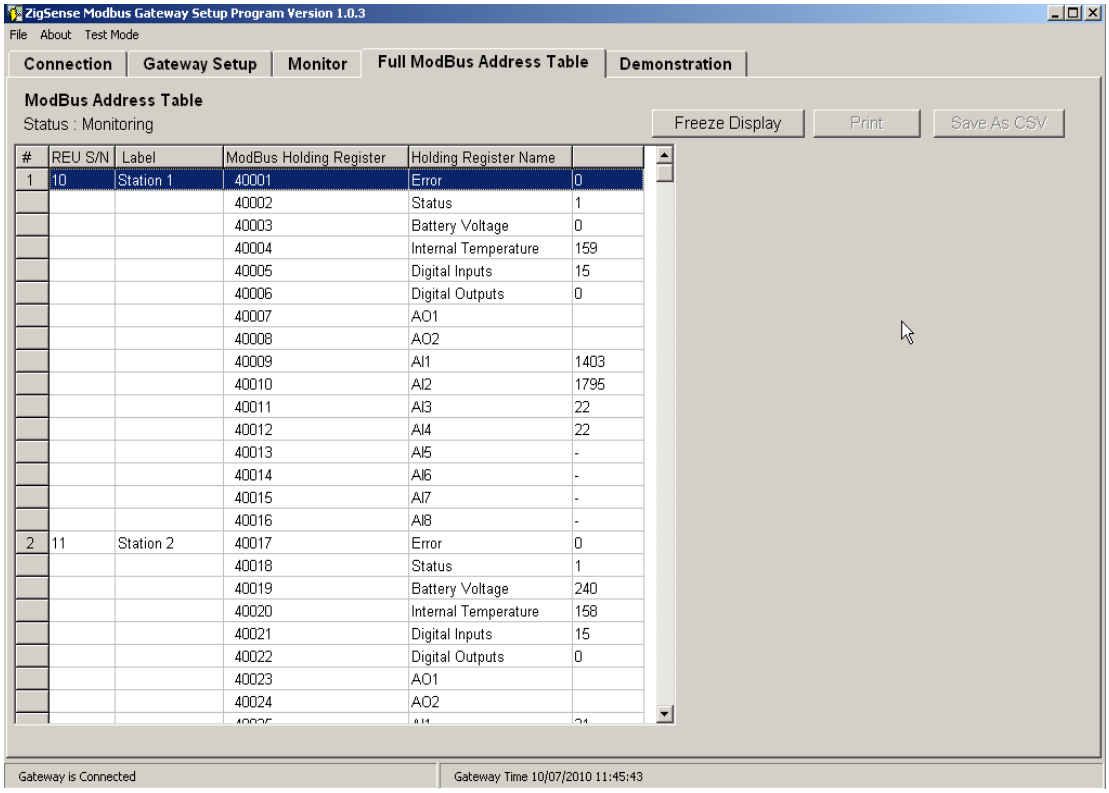
Messages – Is displayed above the table. It Identifies messages sent by a specific REU

10.6 THE FULL MODBUS ADDRESS TABLE TAB

By selecting the **Full Modbus Address Table** tab, it is possible to view additional details regarding Modbus Holding Registers associated with each REU

During the **JOIN** process, each REU node is automatically allocated a memory block of 16 Modbus Holding Registers by the gateway. The first REU node to JOIN the gateway (CGU) will be allocated the first block of pre-defined Holding Registers starting at address 40001. Since the length of each allocated block is always 16 registers, the next REU will be allocated the next block starting at address 40017

The REU column in the table below displays the inherent S/N of the REU. The order in which the S/N is displayed in the REU S/N column is related to the order in which the REU nodes have joined the CGU. In this case: REU 10 then REU 11



#	REU S/N	Label	ModBus Holding Register	Holding Register Name	
1	10	Station 1	40001	Error	0
			40002	Status	1
			40003	Battery Voltage	0
			40004	Internal Temperature	159
			40005	Digital Inputs	15
			40006	Digital Outputs	0
			40007	AO1	
			40008	AO2	
			40009	AI1	1403
			40010	AI2	1795
			40011	AI3	22
			40012	AI4	22
			40013	AI5	-
			40014	AI6	-
			40015	AI7	-
			40016	AI8	-
2	11	Station 2	40017	Error	0
			40018	Status	1
			40019	Battery Voltage	240
			40020	Internal Temperature	158
			40021	Digital Inputs	15
			40022	Digital Outputs	0
			40023	AO1	
			40024	AO2	

Starting with ZigSoft ver.1.34 a new concept of sensors Library .ini file was introduced. This file holds information pertaining to calibrated sensors or range of known input signals. The same calibrated data can later be used to display scaled values in the ZigSoft Modbus table. During installation the .INI file is installed in this location:
C:\Program Files\Conlab\ZigSoft\deviceinfo\zigsoft standard sensors library.ini

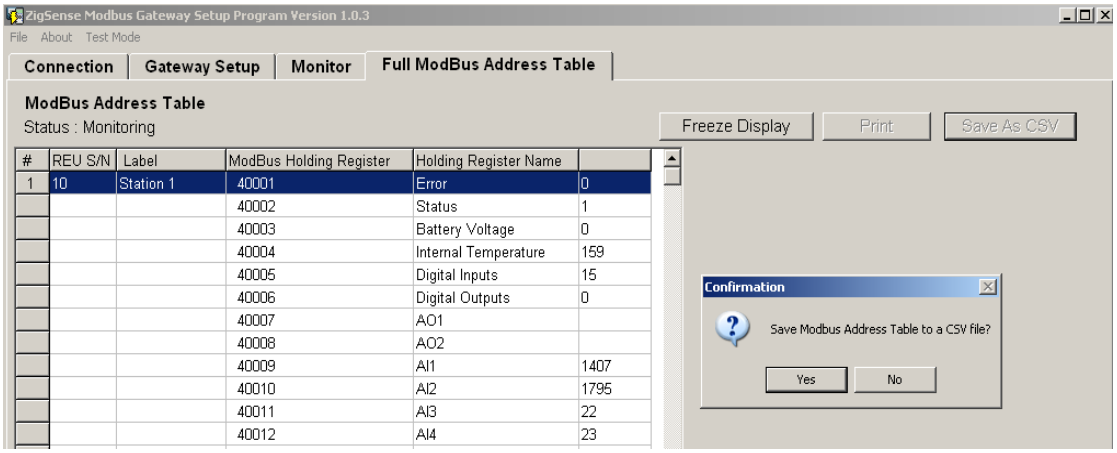
When ZigSoft is first run a new folder will be created as follows:

Win XP: C:\Documents and Settings\All Users\ZigSoft\zigsoft standard sensors library.ini
Win 7: C:\Users\public\public document\ZigSoft\bin\ zigsoft standard sensors library.ini

If you wish to send an updated ini file to your clients (or receive a new one from your supplier), ensure to replace the original sensor library .ini file in all public folders

10.7 EXPORT OR PRINT MODBUS TABLE TO CSV

To assist system integrators it is possible to save the CGU Modbus table into a file in a CSV format. It is also possible to print the table. Before you save or print the table you will need to select the Freeze Display button.



When the freeze display button is selected all dynamic data displayed in the table will temporarily not be updated. This feature is can be used by system integrators to temporarily analyse overall system behaviour and data reading. When saving or printing the table will exit its “freeze” condition after pre-defined time

When a gateway is not set-up to communicate to remote nodes it requires an initial set- up. The options are:

- Connect to Gateway (default Modbus address of the gateway is: 1)
- Create a New Gateway Set-up
- Load a Gateway Set-up from a previously saved CSV file

Connect to Gateway
Disconnect from Gateway
Create New Gateway Setup
Load Gateway Setup from CSV File
Exit (Close the main window)
Start Demonstration
Gateway is Not Connected
To connect the ZigSense Gateway...
- Connect the USB cable between the ZigSense Gateway and the computer.
- Click the "Connect to Gateway" button.

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11. REU – INPUT OUTPUT (IO) WIRING BOARD

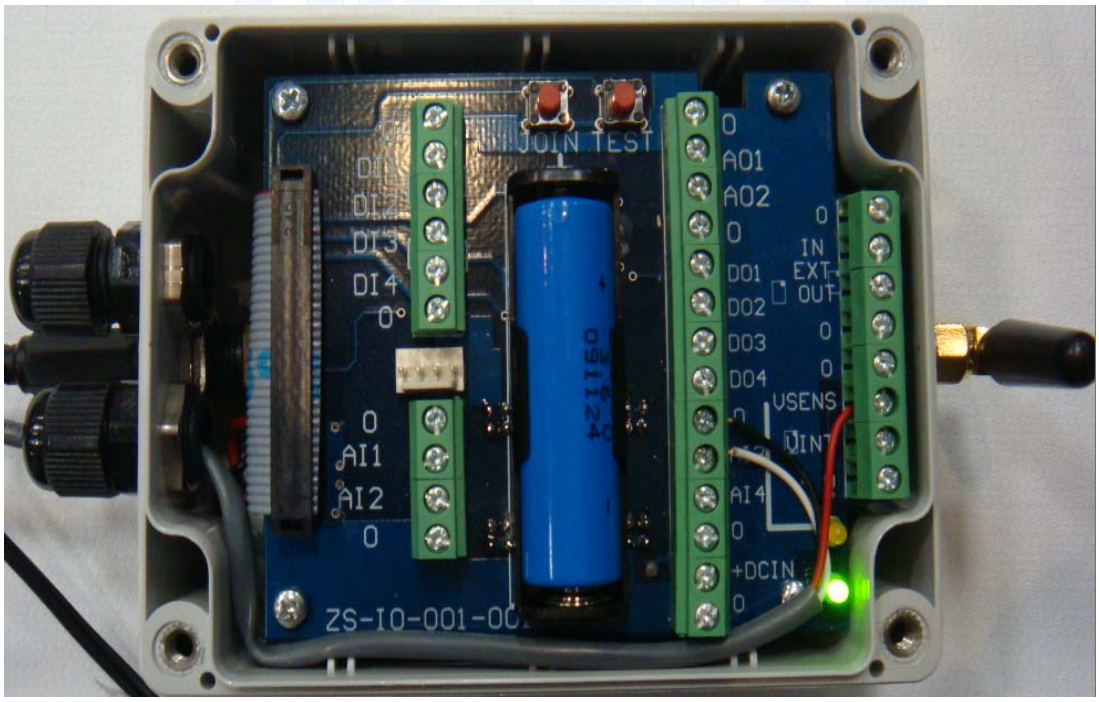
The screen capture below illustrates an assembled ZigSense REU and its main IO board.

IO board model ZS-IO-001 (shown) includes the following IO combination:

4 x Digital Inputs,
4 x Digital Outputs,
4 x Analogue Inputs,
2 x Analogue Outputs

There are different IO boards and IO combinations designed to interface to various signal sources. Each IO board is identified by the code: ZS-IO-XXX where XXX represents a model/catalogue number indicating different IO combination and functionality

ALWAYS DISCONNECT THE EXTERNAL POWER SUPPLY AND REMOVE THE INTERNAL 3.6VDC LITHIUM BATTERY PRIOR TO PERFORMING ANY WIRING OF EXTERNAL DEVICES

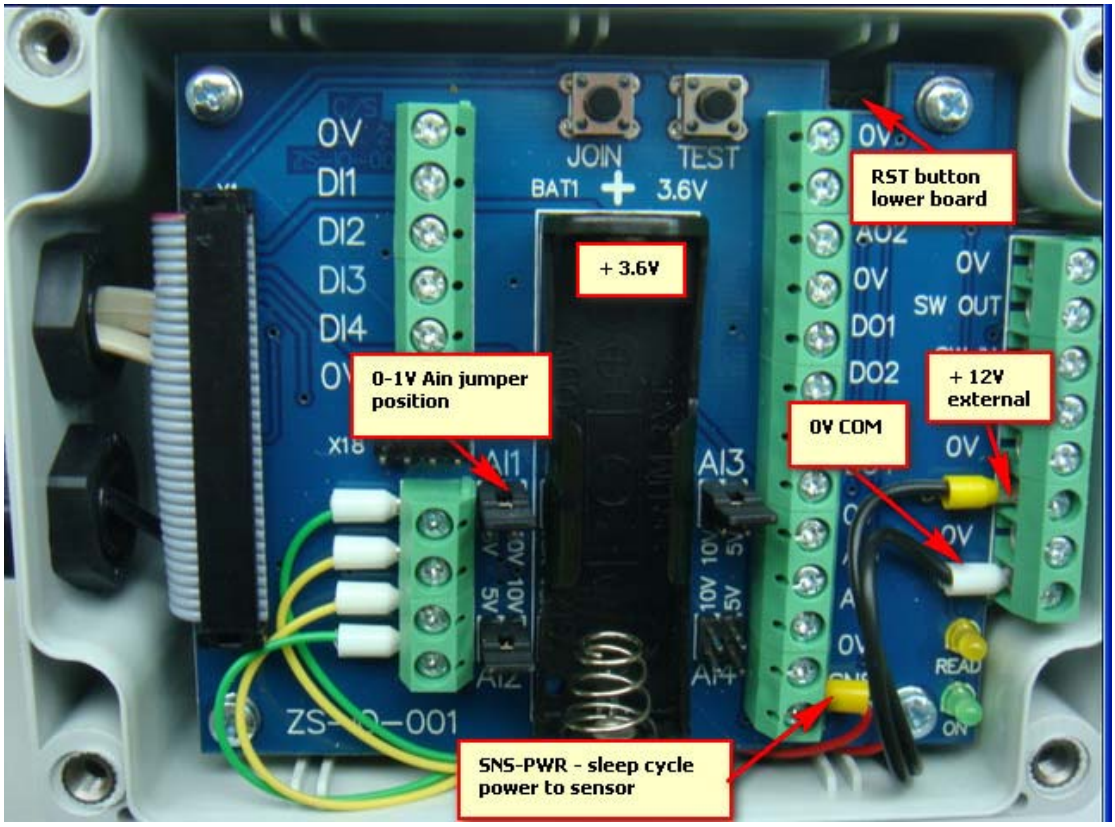


11.1 POWER SUPPLY

The ZigSense REU is powered by an external supply of **12VDC (max) 500mA** and an optional internal AA 3.6VDC Lithium backup battery. The battery powers the ZigSense communications board whenever external power is lost.

It is recommended whenever possible to use the external power supply. It is recommended to insert the AA Lithium 3.6VDC battery only when the REU is ready to be fully operational on-site and only after the REU has JOINED the gateway

ALWAYS DISCONNECT THE EXTERNAL POWER SUPPLY AND REMOVE THE INTERNAL 3.6VDC LITHIUM BATTERY PRIOR TO PERFORMING ANY WIRING OF EXTERNAL DEVICES



A GREEN LED at the right hand corner of the IO board will lit **ON** continuously whenever the REU is powered by an external DC power supply

EXTERNAL DC POWER SUPPLY SPECIFICATION: **12VDC 500mA, absolute maximum**

11.2 POWERING EXTERNAL SENSORS – DIRECT OR DELAYED POWER

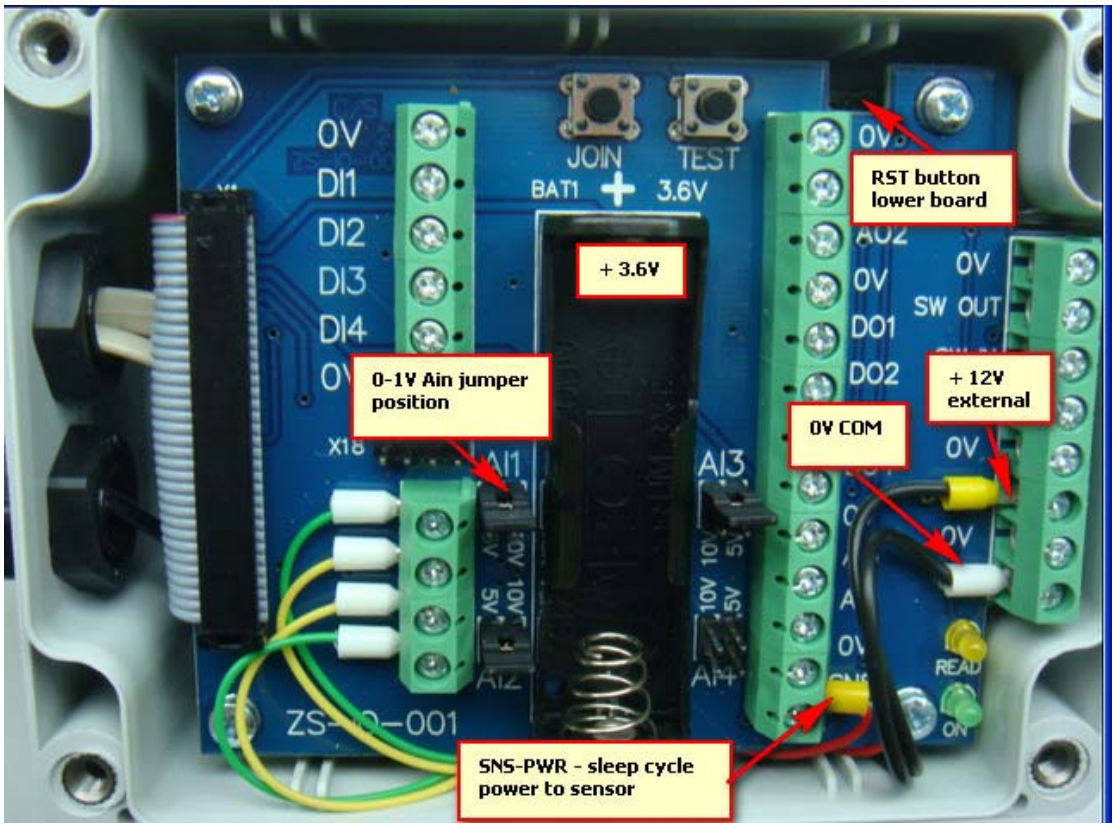
REU nodes are designed to power external sensors based on two strategies:

1. Power is always ON - Wiring the sensor supply directly to the DC supply
2. Power is delayed – Wire the sensor to a time delayed Digital Output point

SENSORS ARE POWERED CONTINUOUSLY

A YELLOW (READ) LED will flash whenever the RUE samples (reads) its inputs

Under external power supply: **READ** LED will flash **every 5 seconds**
Under backup battery power: **READ** LED will flash **every 30 seconds**



IF YOU USE THE REU OWN DC POWER SUPPLY TO POWER AN EXTERNAL SENSOR, PLEASE ENSURE THAT THE SENSOR'S POWER REQUIREMENT DO NOT EXCEED THE AVAILABLE DC SUPPLY VOLTAGE AND CURRENT

SAMPLE & HOLD: TIME DELAYED DC POWER TO EXTERNAL SENSORS

Delayed power to external sensor can be controlled by activating a SAMPLE & HOLD routine.
Note: Sample & Hold requires special firmware and pre-defined IOs

Application example: An external source of 4 to 20mA signal is wired to Ain1. You need to determine the delayed power (in Seconds/Minutes) that is applied to the external source sensor:

Setting of SAMPLE & HOLD function is enabled (Requires special firmware)

1. Ensure that the REU is powered and running

2. Push the TEST button inside the REU considering the following points:

- **If Din1 is NOT wire linked to 0V → Ain1 input is sampled every 15 minutes**
- **If Din1 IS wire linked to 0V → Ain1 input is sampled every 30 seconds**

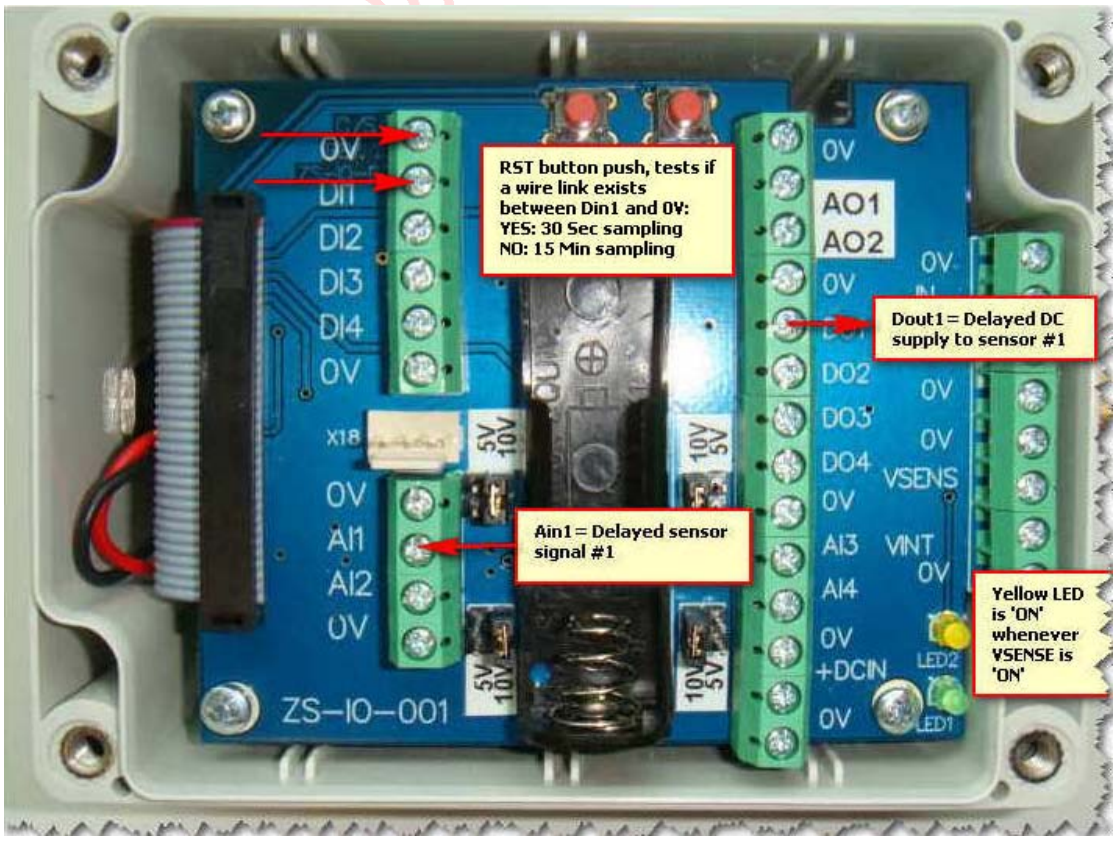
Dout1 completes the sensor powering circuit by applying 0V when activated

Please see Chapter 11.6 and 11.7 for proper Digital Output wiring

SAMPLE & HOLD: SAMPLING EVERY 15 MINUTES:

Following activation, at power-up and every 15 minutes thereafter, Dout1 will go LOW (0V) to complete the power circuit to the external sensor and continue to power the sensor till Ain1 sampling period was completed. Sensor data is based on SAMPLE & HOLD routine. At the end of the sensor sampling period Dou1 will go HIGH disconnecting the power to the external sensor for the next 15 minutes

Sampling rate of all other inputs is not affected by the delayed power logic



IF YOU USE THE REU OWN DC POWER SUPPLY TO POWER AN EXTERNAL SENSOR, PLEASE ENSURE THAT THE SENSOR'S POWER REQUIREMENT DO NOT EXCEED THE AVAILABLE DC SUPPLY VOLTAGE AND CURRENT

11.3 ZIGSENSE IO BOARDS

A ZigSense Remote End Unit (REU) is made of two boards.

The lower board – contains the wireless section and the main power supply
The upper board – contains the IO section designed to interface to external or internal sensors or both.

There are different IO boards and IO combinations designed to interface to various signal sources. Each IO board is identified by the code: ZS-IO-XXX where XXX represents a model number indicating the different IO combination and functionality

Below is a list of ZigSense Sensors and standard IO boards.

Voltage + Pulse count	4Ain + 4Din + 4Dout + 2Aout	Voltage	0-1,0-5,0-10 VDC
Current + Pulse count	4Ain + 4Din + 4Dout + 2Aout	Current	4-20ma
Temperature sensor + pulse count	4xAin + 4Din + 4Dout + 2Aout	Voltage	0 – 1V = -40 to +120 Deg C
RTD Pt1000 + pulse count	4xRTD + 4Din + 4Dout + 2Aout	Resistance	-44 to +128 Deg C
Temp. + %RH	1xTemp + 1xRH (Internal) + 2Ain + 4Din +4Dout + 2Aout	Voltage	-50 to 150 Deg C 0%-100%
Temp + %RH	1xTemp + 1xRH (external) + 2Ain + 4Din +4Dout + 2Aout	Voltage	–50 to + 150 Deg C 0%-100%
Soil Moisture + Temp	1Soil Moist + 1Temp + 2Ain + 4Din + 4Dout +2Aout	Voltage	0 – 3V
Modbus MASTER	RS232/RS485 + 4Dout	Serial	Modbus MASTER

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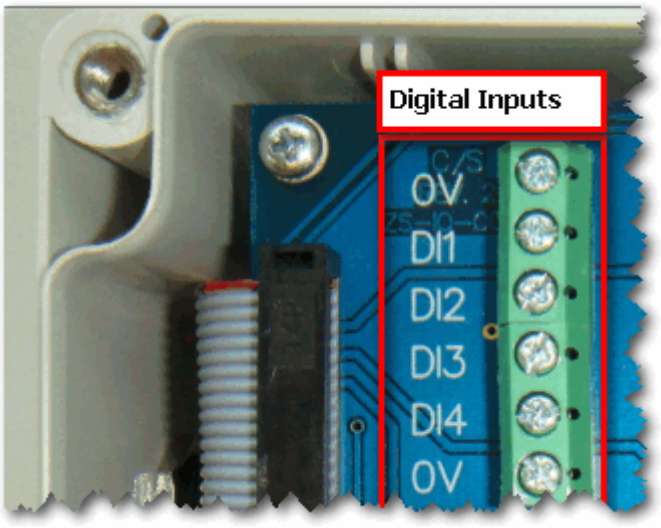
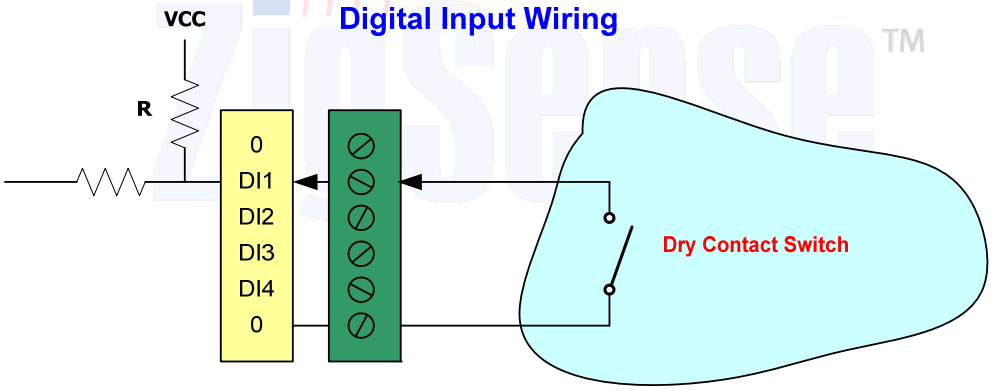
11.4 DIGITAL INPUTS

Digital Inputs can be used to monitor dry contact switch conditions such as ON/OFF





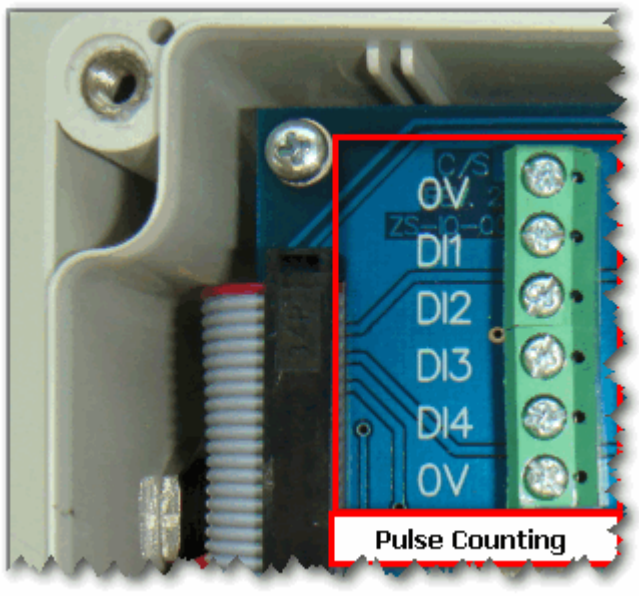
Digital Inputs Logic:
Switch Open – Data is transmitted as Logic '1'
Switch Closed – Data is transmitted as Logic '0'

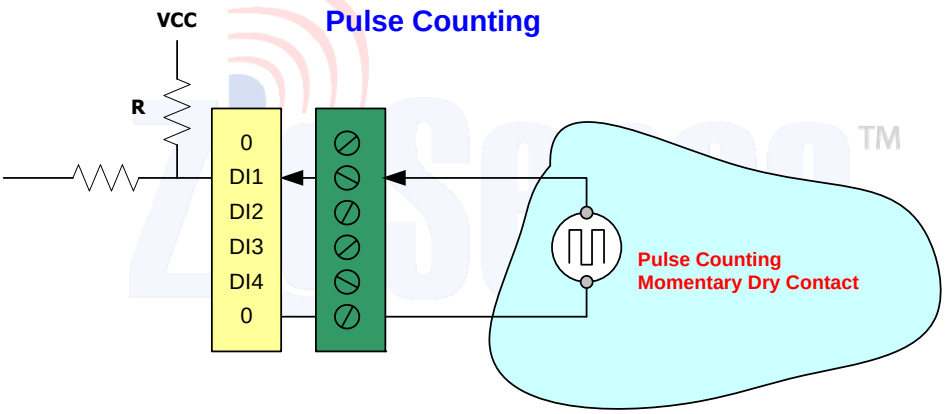
Digital Inputs Specifications:
Input Voltage: REU Internal supply voltage
Isolation: Inputs are not isolated

To prevent unnecessary current drain when operating the REU under battery power, ensure that the dry contacts wired to the Digital Inputs are only closed momentary

11.5 PULSE COUNTING INPUTS

The ZigSense REU Digital Inputs are designed as pulse counter inputs.
Pulse counting inputs will operate with Reed relays or any other dry contact switches





Pulse Inputs Logic:
Switch Open – Data is transmitted as Logic '1'
Switch Closed – Data is transmitted as Logic '0'

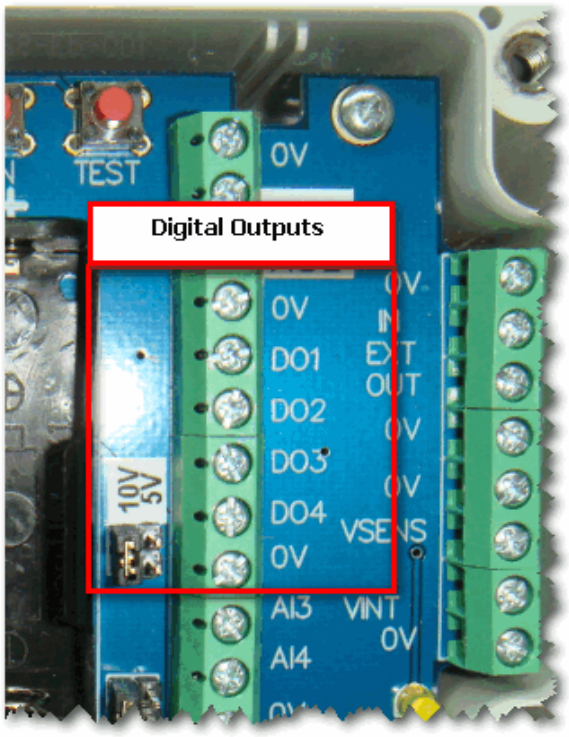
Pulse Inputs Specifications:
Input Voltage: Internal supply voltage
Isolation: Inputs are not isolated
Pulse Frequency: 5 – 8Hz Absolute maximum
Higher frequency can be accommodated through design modifications

4 Counters Accumulators are associated to the 4 Digital inputs of REU
Din1 → C1, Din2 → C2, Din3 → C3, Din4 → C4
Pulse counting occurs even when the REU is in its SLEEP cycle

Pulse counting accumulated data is transferred to the gateway's Modbus Holding Registers. All 4 Counters accumulators can be RESET remotely by sending a single register WRITE command – Value=0 (HEX) - to the appropriate Modbus Holding register associated with the specific Counter / Digital Input

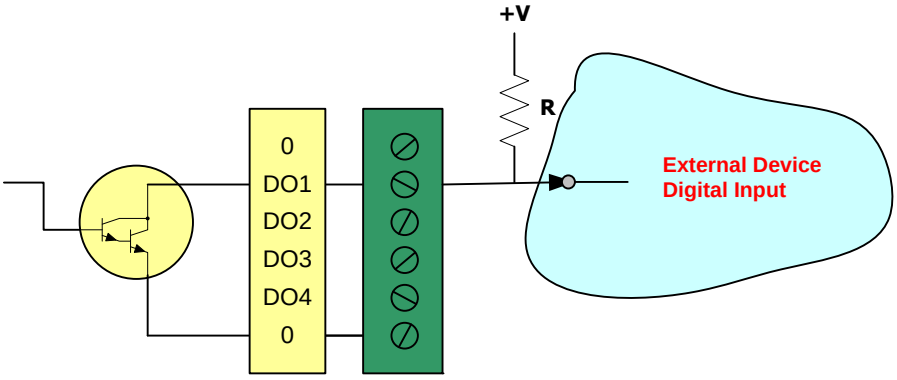
11.6 DIGITAL OUTPUTS – TRANSISTOR OUTPUTS

Digital outputs can be used to drive external devices based on ON/OFF commands transferred to the REU via the gateway



Digital outputs ON/OFF commands are triggered based on the combined wireless network performance and the sleeping cycle of each REU node. If REU is operating based on sleep cycle of 5 seconds, an ON/OFF command to its digital output sent from a PLC (via the gateway) may be delayed by at least 5 seconds

Digital Output Wiring - Open Collector NPN sinking

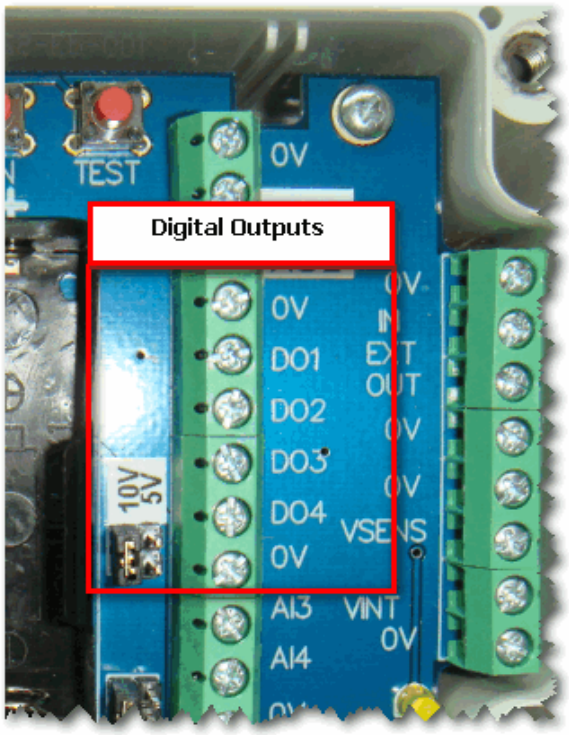


Digital Outputs specifications:
DC Output Voltage Absolute maximum: +30VDC
DC Output Current Absolute maximum: 250mA per output

ZIGSENSE NODES SHOULD NOT BE USED FOR REAL TIME CONTROL

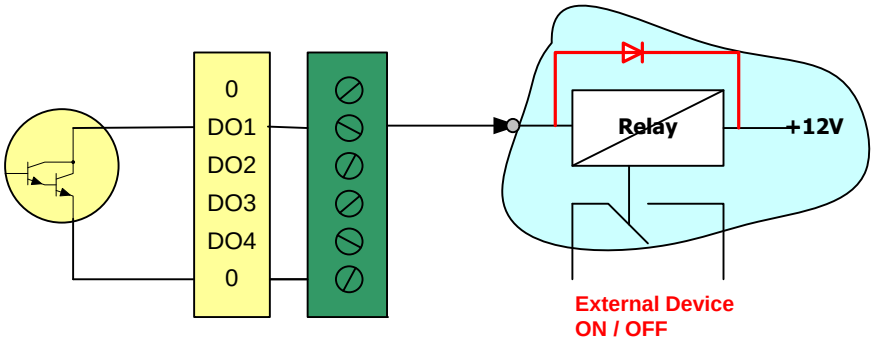
11.7 DIGITAL OUTPUTS – INTERFACE TO EXTERNAL RELAY

Digital outputs can be used to drive external devices based on ON/OFF commands transferred to the REU via the gateway



Digital outputs ON/OFF commands are triggered based on the combined wireless network performance and the sleeping cycle of each REU node. If REU is operating based on sleep cycle of 5 seconds, an ON/OFF command to its digital output sent from a PLC (via the gateway) may be delayed by at least 5 seconds

Digital Output Wiring – External Relay



Digital Outputs specifications:

DC Output Voltage Absolute maximum: +30VDC

DC Output Current Absolute maximum: 250mA per output

To protect REU digital outputs from damage when using external relays, wire a protection diode in parallel to the relay coil as shown

ZIGSENSE NODES SHOULD NOT BE USED FOR REAL TIME CONTROL

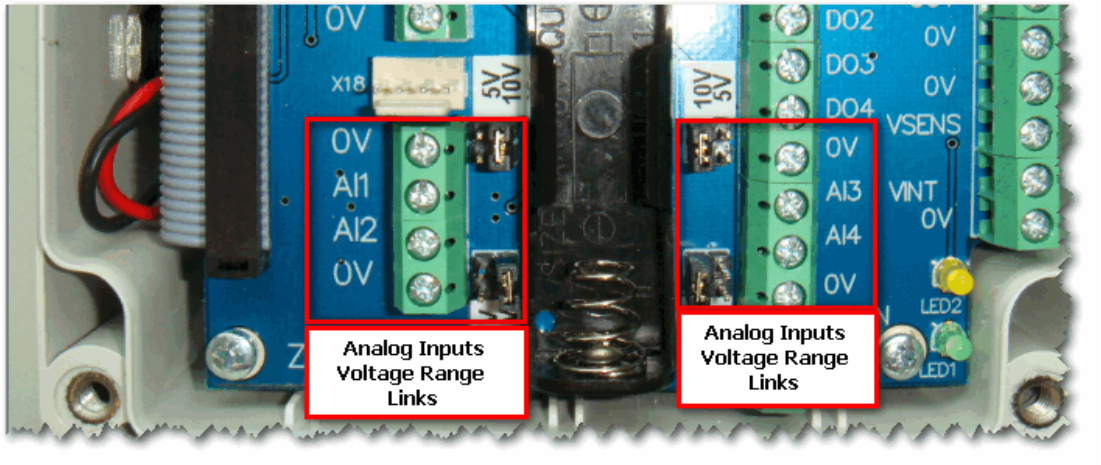
11.8 ANALOG INPUTS – DC VOLTAGE

ZigSense IO board model ZS-IO-001 supports up to four (4) Analogue inputs.
These inputs are ready to accept external DC voltage sources in three (3) ranges.

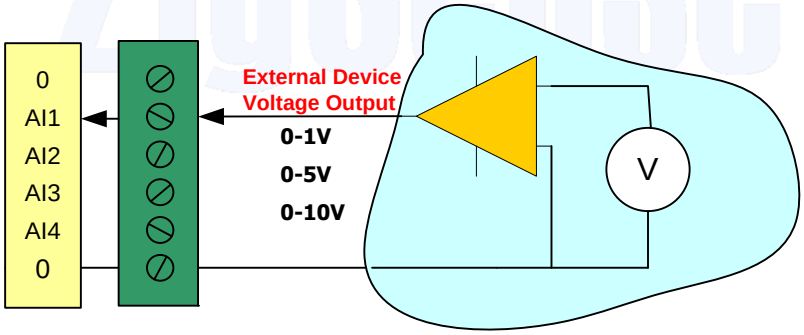
ANALOG INPUTS VOLTAGE GAIN LINKS

Note: Either no links are used OR one link ONLY per voltage range is allowed

Analog In / Range	0 – 1VDC	0 – 5VDC	0 – 10VDC
Analog In 1	No Link	Link AI1 - 5V	Link AI1 - 10V
Analog In 2	No Link	Link AI2 - 5V	Link AI2 - 10V
Analog In 3	No Link	Link AI3 - 5V	Link AI3 - 10V
Analog In 4	No Link	Link AI4 - 5V	Link AI - 10V



Analog Input Wiring (Voltage)



Analog Input Specifications:

Input Voltage: 12VDC Absolute Maximum
Selectable Input Voltage Range: 0-1VDC / 0-5VDC / 0-10VDC
Isolation: Analog inputs are not isolated

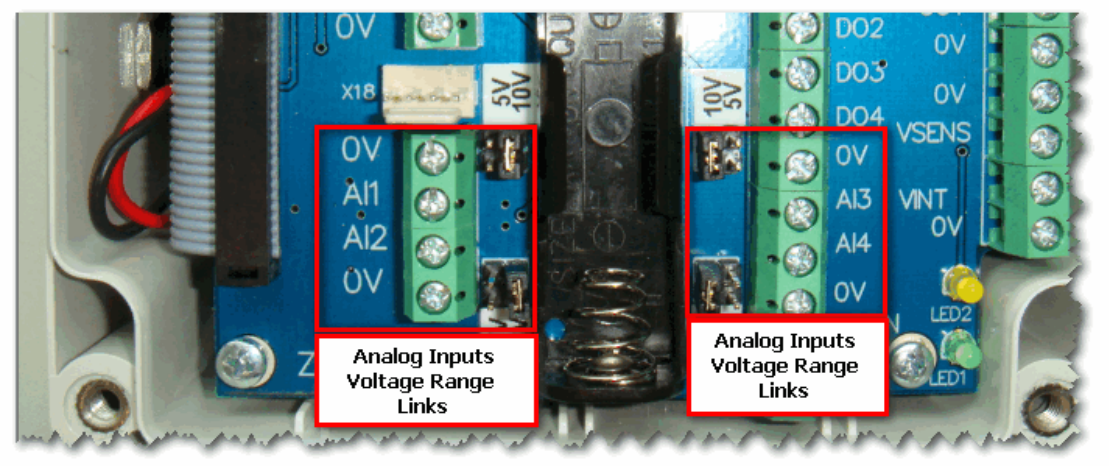
Decoding Analog Input raw data in the Gateway's Holding Registers

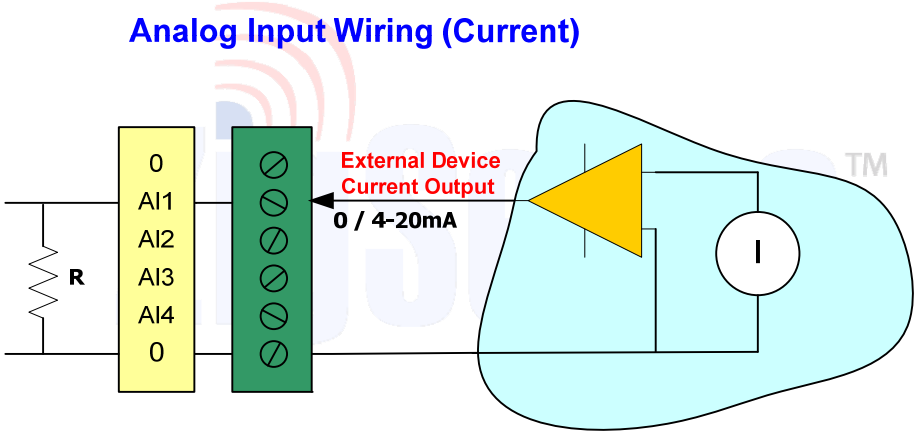
1 Volt Range: Vin = (1 /4095) * Raw Data
5 Volts Range: Vin = (5 /4095) * Raw Data
10 Volts Range: Vin = (10 /4095) * Raw Data

The Holding Register range is: 0 to 4095
Isolation: Analog inputs are not isolated

11.9 ANALOG INPUTS – 0/4 - 20MA DC CURRENT

ZigSense IO board model ZS-IO-002 supports up to 4 Analogue inputs ready for external DC current of 0-20mA or 4-20mA





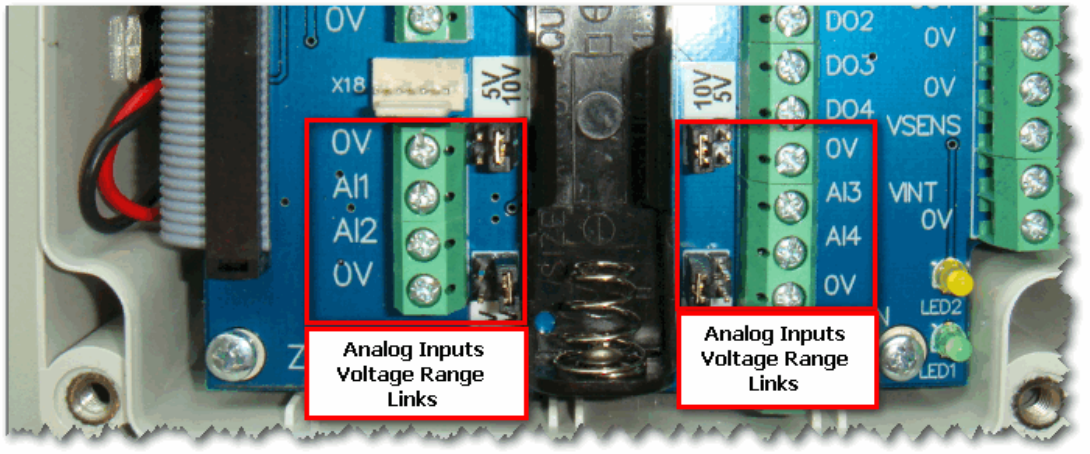
Analog Input Specifications:
Input Current: 20mA Absolute Maximum
Isolation: Analog inputs are not isolated

Decoding Analog Input raw data in the Gateway's Holding Registers
I (mA) = (Raw Data /4095)*20

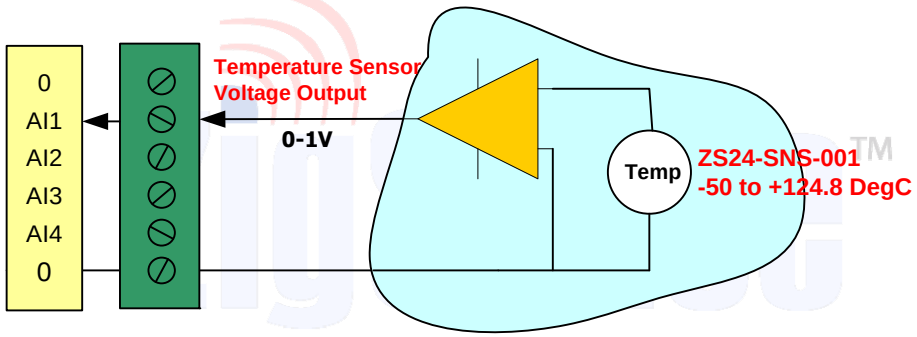
The Holding Register range is: 0 to 4095
Isolation: Analog inputs are not isolated

11.10 ANALOG INPUTS – TEMPERATURE ZS-SNS-001 SENSOR

ZigSense IO board model ZS-IO-001 supports up to four 4 x analogue temperature signal generated by Temperature sensor model ZS-SNS-001 with output of: 0 – 1VDC



Analog Input - Temperature Sensor (Volts)



Temperature Sensor Specifications:
Temperature range: -50 to + 124.8
Voltage Output: 0 to 1VDC

Decoding Analog Temperature Input raw data in the Gateway's Holding Registers
Temperature (C°) = ((124-(-44))/4095 * ((Raw Data) – 44)
Holding Register range is: 0 to 4095
0 = -50 Deg C and 4095 = 128 Deg C

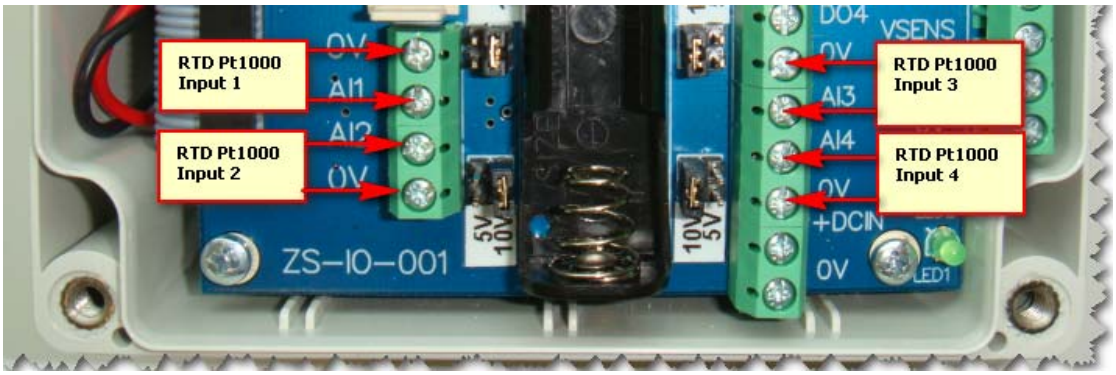
Temperature sensor model ZS-SNS-001 is supplied with 2m cable. It is possible to mix temperature sensor signal with standard Voltage inputs.
Use GAIN links for the correct voltage range

Isolation: Analog inputs are not isolated

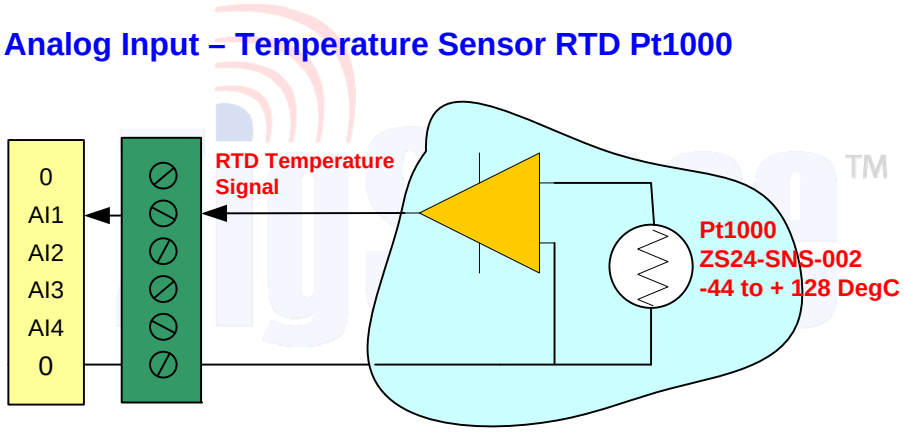
Check REU IO configuration functions in ZigSoft – See chapter 12 for more details

11.11 ANALOG INPUTS – RTD PT1000 SENSOR INTERFACE

ZigSense IO board model ZS-IO-004 supports 4 x analogue temperature signals generated by model ZS-SNS-002 - RTD Pt1000 2-Wire. The sensor response is pre-calibrated to -44degC to + 128degC temperature range



Wiring of the 2-Wire RTD sensors is similar to the voltage inputs as shown below.



Decoding RTD Pt1000 raw data in the Gateway's Holding Registers:

The temperature range is approx. -44degC to + 128degC
Temperature (C°) = [(128-(-44)/4095] * (Raw Data) – 44

Range of raw data in the Holding Register is: 0 to 4095

RTD Temperature sensor ZS-SNS-002 is supplied with 2m cable

Isolation: Analog inputs are not isolated

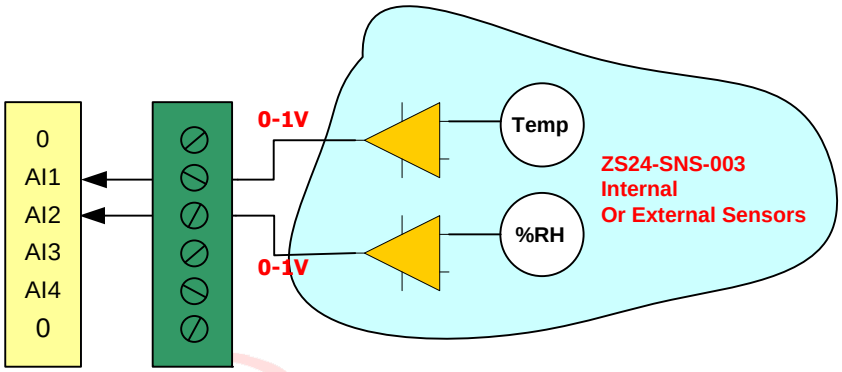
11.12 ANALOG INPUTS - TEMPERATURE + % RELATIVE HUMIDITY SENSORS

ZigSense remote node with IO board model ZS-IO-008 includes built-in combined
% Relative Humidity + Temperature sensor cat# ZS-SNS-003

There are two type sensors models:
Internal ZS-SNS-003 – Combined Temp + %RH (internal sensor)
External ZS-SNS-003E – Combined Temp + %RH (external sensor)

The combined sensors generate two voltage outputs:
Temperature output of 0 – 1VDC and Humidity output of 0 – 1VDC

Temperature + %RH sensor

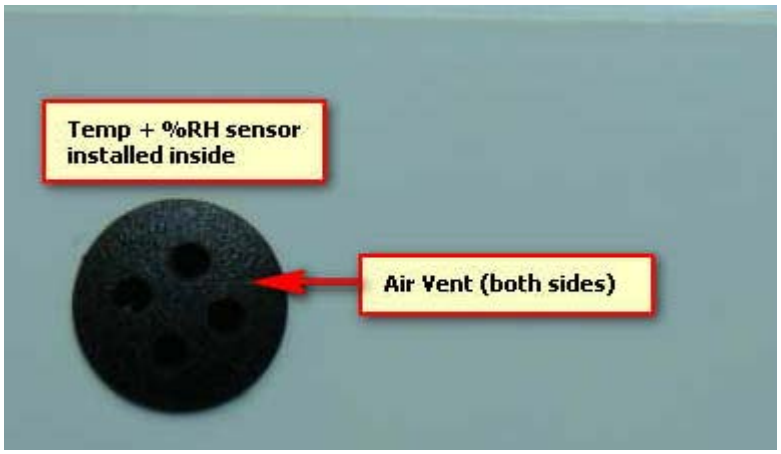


Internal %RH+TEMP sensor specifications
TEMP Range: -50 to + 150 °C
%RH Range: 0% to 100%

Decoding Analog Temperature Input raw data in the Gateway's Holding Registers
-50 to + 150 C° → = 0 – 4095 → 0 to 1VDC
Temperature C° = (Raw Data/4095)*(200) -50

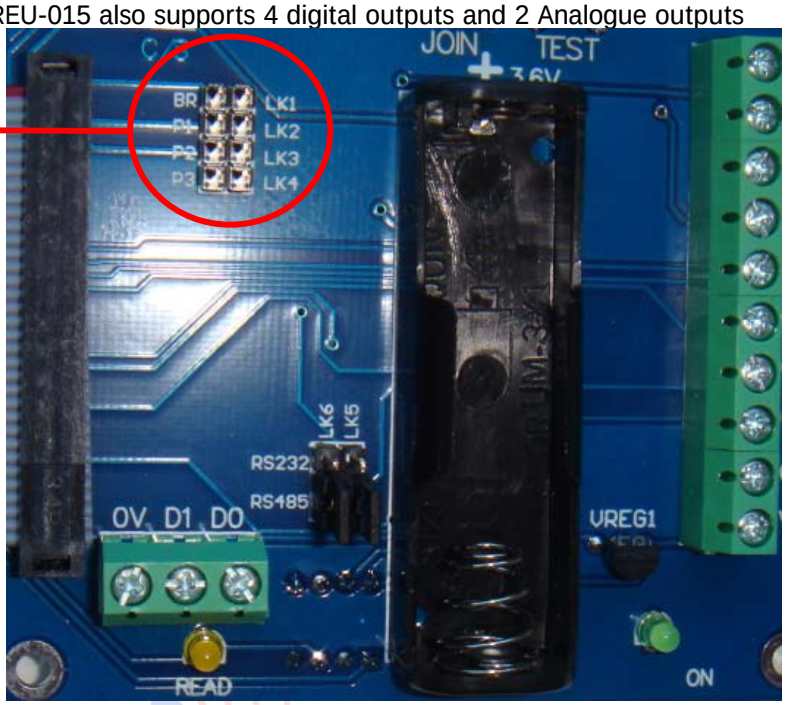
0 to + 100 %RH → = 0 – 4095 → 0 to 1VDC
%Relative Humidity = (Raw Data/4095)*100

Sensor ZS-SNS-003E (external version of the sensor) is supplied with 2m cable
Isolation: Analog inputs are not isolated.
When the sensor is installed inside the REU, the enclosure contains two air vents

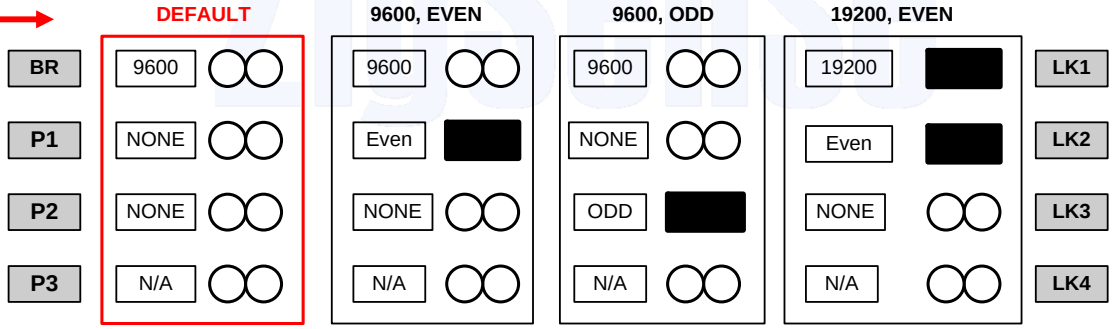


11.13 REU Modbus MASTER - SERIAL INTERFACE

ZigSense model ZS24-REU-015 Modbus 'Master' interfaces between a remote Modbus 'slave' device and the gateway. Data stored in the 'slave' holding registers (max. 8) is transferred over the wireless network similarly to all other ZigSense nodes. In addition to the above model ZS24-REU-015 also supports 4 digital outputs and 2 Analogue outputs



Communications settings (DEFAULT): 9600, N, 8, 1
BR = Baud Rate

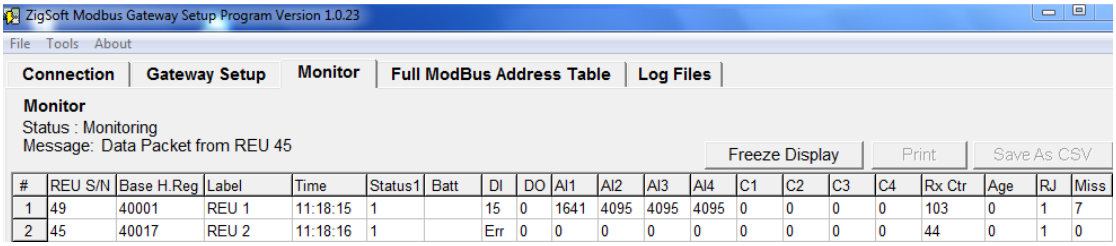


Protocol selection: RS232 / RS485

RS232 / RS485 cable wiring

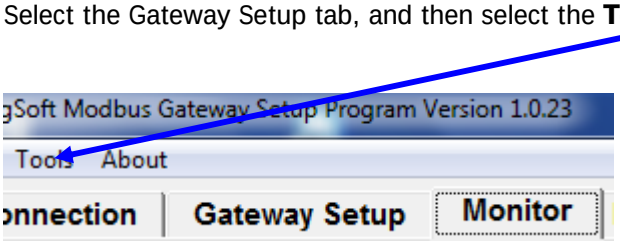
11.14 Modifying Modbus MASTER Settings using ZigSoft

The Modbus REU node is programmed using default settings as described in 11.13 above.


ZigSoft Modbus Gateway Setup Program Version 1.0.23
File Tools About
Connection Gateway Setup Monitor Full ModBus Address Table Log Files
Monitor
Status : Monitoring
Message: Data Packet from REU 45
Freeze Display Print Save As CSV

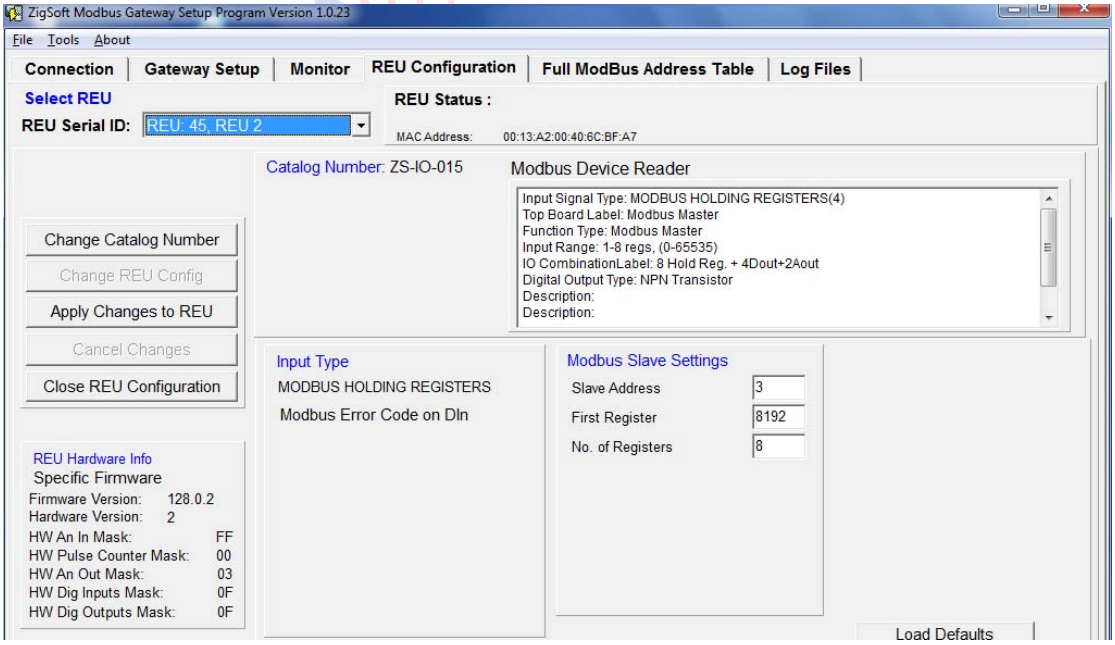
#	REU S/N	Base H.Reg	Label	Time	Status1	Batt	DI	DO	AI1	AI2	AI3	AI4	C1	C2	C3	C4	Rx Ctr	Age	RJ	Miss
1	49	40001	REU 1	11:18:15	1		15	0	1641	4095	4095	4095	0	0	0	0	103	0	1	7
2	45	40017	REU 2	11:18:16	1		Err	0	0	0	0	0	0	0	0	0	44	0	1	0

Select the Gateway Setup tab, and then select the **Tools** function



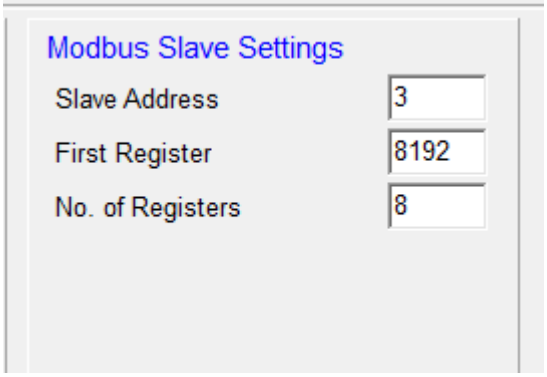
Select the relevant REU (shown S/N#45) from the REU Serial ID down list
Wait few seconds till the relevant data (sent over the air form the relevant REU) is displayed

Note: If the REU you have selected is not online there will be an error No Response message

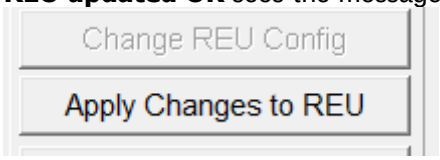


For more information about REU remote configuration options please see chapter 12

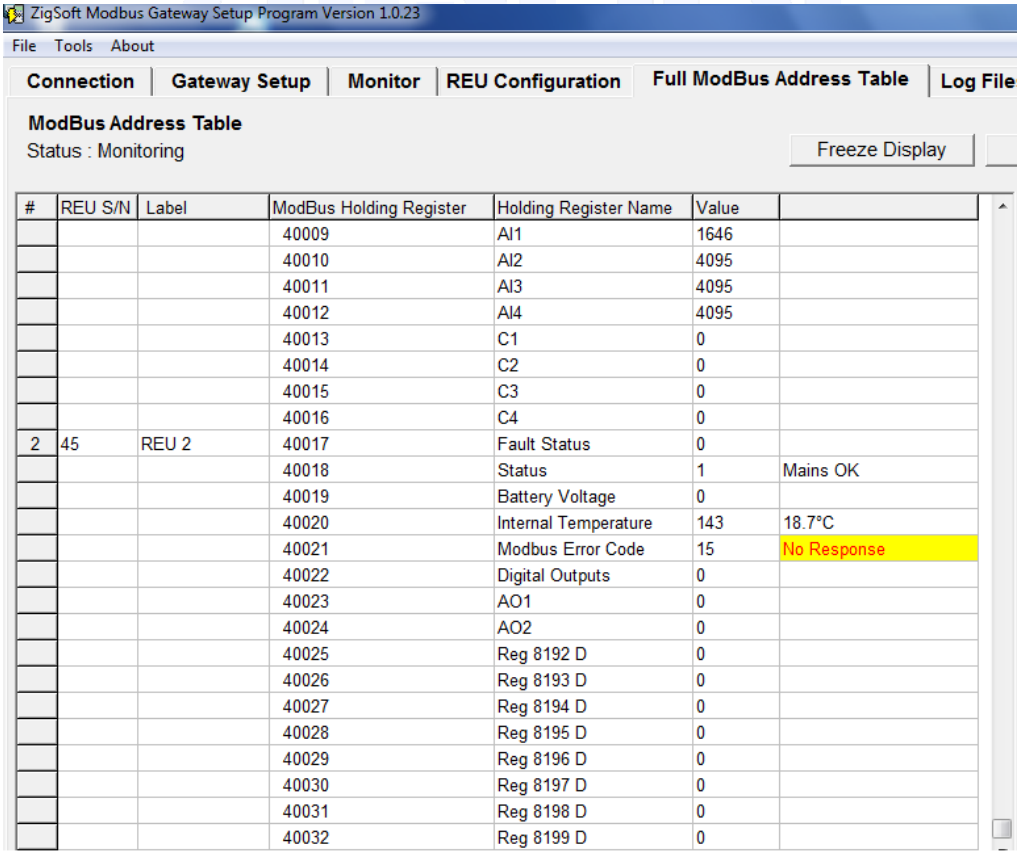
Modify the Modbus Slave Settings as per the specific remote Modbus Slave device you are trying to connect to. Remember! Only Holding registers are supported



Once modified, select Apply Changes to REU button and wait for a message **REU updated OK** sees the message at bottom of the page



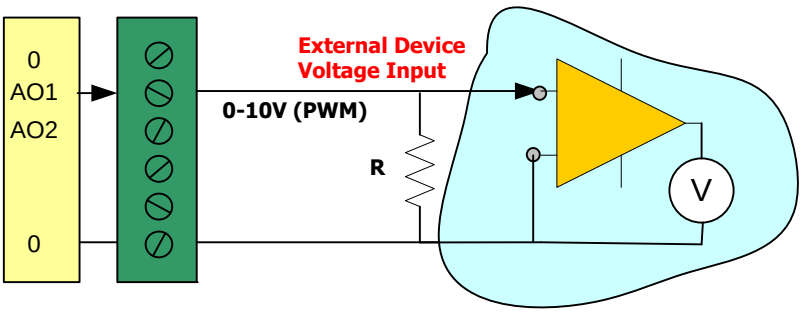
Wait a while till the data is updated in the Modbus Table. The new settings are transferred over the air (OTA) to the remote node and are confirmed on the return path. The message Modbus Error Code: No Response is an indication that the remote Modbus Slave device is not connected or not answering


ZigSoft Modbus Gateway Setup Program Version 1.0.23
File Tools About
Connection Gateway Setup Monitor REU Configuration Full ModBus Address Table Log File
ModBus Address Table
Status : Monitoring
Freeze Display

#	REU S/N	Label	ModBus Holding Register	Holding Register Name	Value	
			40009	AI1	1646	
			40010	AI2	4095	
			40011	AI3	4095	
			40012	AI4	4095	
			40013	C1	0	
			40014	C2	0	
			40015	C3	0	
			40016	C4	0	
2	45	REU 2	40017	Fault Status	0	
			40018	Status	1	Mains OK
			40019	Battery Voltage	0	
			40020	Internal Temperature	143	18.7°C
			40021	Modbus Error Code	15	No Response
			40022	Digital Outputs	0	
			40023	AO1	0	
			40024	AO2	0	
			40025	Reg 8192 D	0	
			40026	Reg 8193 D	0	
			40027	Reg 8194 D	0	
			40028	Reg 8195 D	0	
			40029	Reg 8196 D	0	
			40030	Reg 8197 D	0	
			40031	Reg 8198 D	0	
			40032	Reg 8199 D	0	

11.15 ANALOG OUTPUT

Analog Output Wiring (Voltage PWM)



Analog outputs specifications

The Analog output signal is derived from a PWM signal. This signal must still be filtered externally before it can be considered a pure voltage output

Analog Voltage Output: 0 to 10VDC +/- 0.6% MAX
External power supply: use only 12VDC supply
Minimum External Load: 10K

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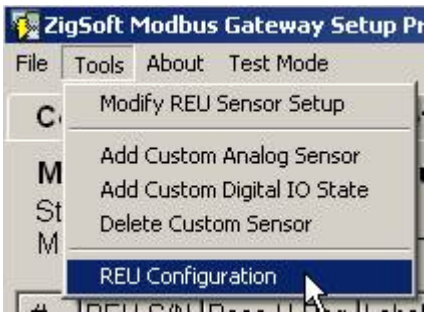
12. MODIFYING REU CONFIGURATION

ZigSoft enables system integrators to modify the REU configuration over the air (OTA):

1. Modify REU general configuration
2. Configure sensors (analogue and digital) wired to its inputs (existing or new)

12.1 REU general parameters

From the Tools menu select the REU configuration option

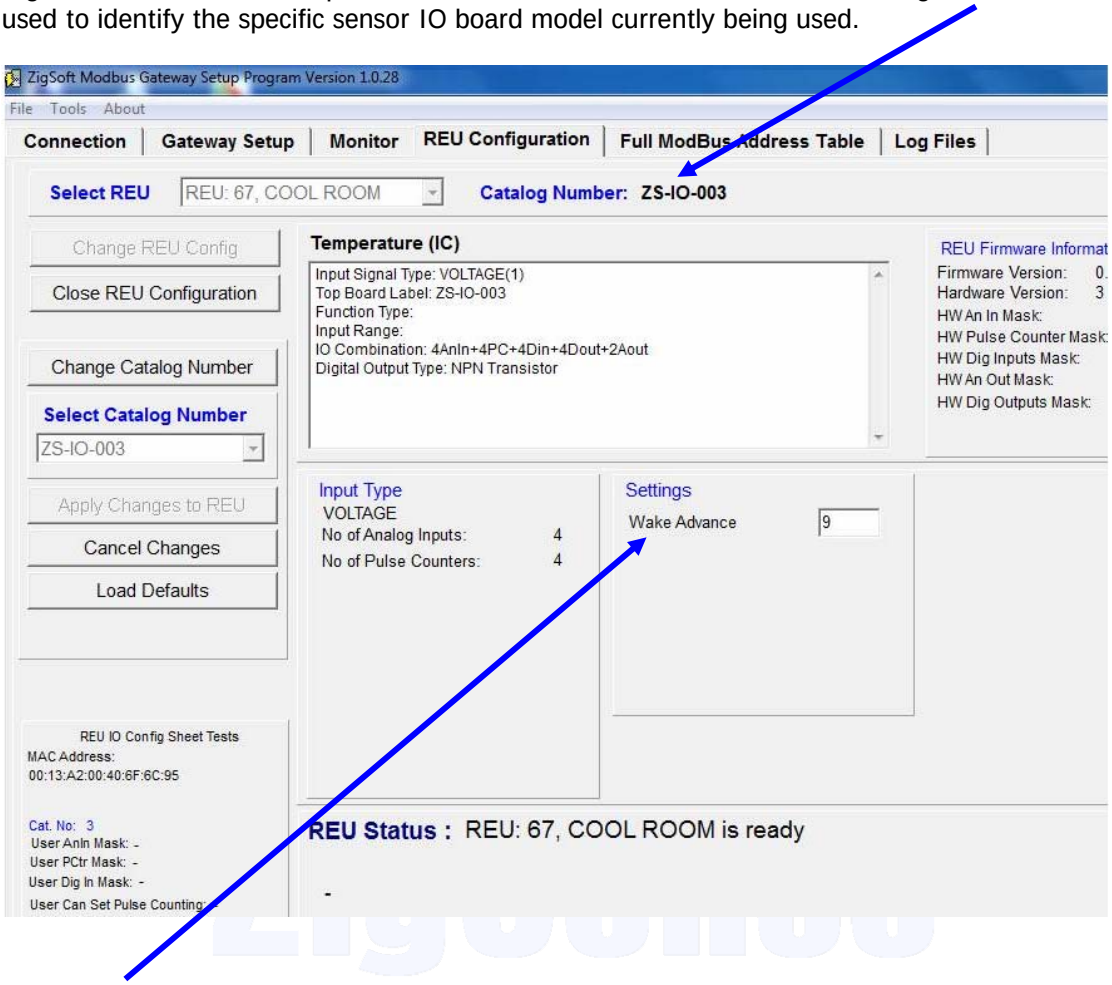


Then select from the list the specific REU S/N you wish to configure

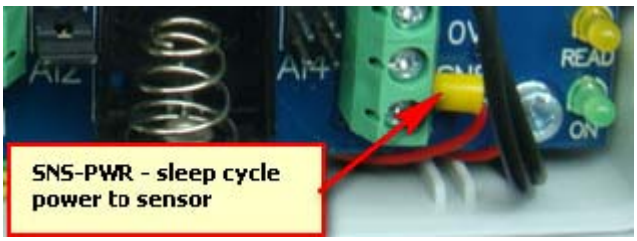
When selecting a specific REU S/N from the list, the REU details will be displayed at the bottom of the configuration page only if the specific REU is currently communicating to the gateway, In this case the message will be:

If there a REU lost communications or is not powered the message will indicate No Response from REU XXXXXX

Once selected, the specific REU S/N and node description (eg. Cool Room) will be displayed together with its standard specifications. Each REU is associated with a catalogue number used to identify the specific sensor IO board model currently being used.



12.2 Wake Advance function: Each REU may have different IO board and sensors. Powering of low power sensors can be controlled by wake-sleep cycle through the **SNSPWR** terminal.



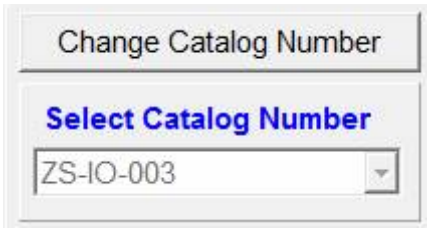
If a low power sensor is powered by the **SNSPWR** wiring terminal (as shown above) the sensor will be powered only when the REU is awake. To ensure that a sensor is powered long enough for the REU to read stable data the **Wake Advance** function was introduced.

Each catalogue number is associated with a default Wake Advance parameters. This number can be 'tweaked' manually if needed. The maximum value for wake advance value is 32 measured in part of a second. Examples:
Wake advance = 5 → 5/32 of a Sec. Wake advance = 32 → 32/32 (Whole 1 Sec)
If the sensor is powered externally the Wake Advance function has no effect but is still controlled by the processor.

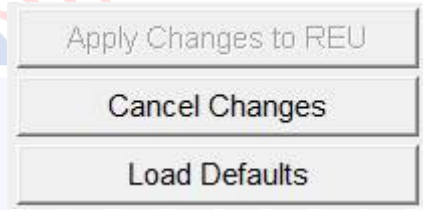
12.3 Change, Save REU configuration parameters

To modify the REU configuration you need to select the **Change REU Configuration** button

To modify an IO board catalogue number you need to select the **Change Catalogue Number** button, then open the down list to reveal other catalogue numbers.
This option may be useful if you decide to swap top IO board and utilise different functionality. Note: the main REU board does not carry a catalogue number.



Once the right catalogue number is selected, select the Apply Changes to REU button.



Then close the configuration page

It is up to the system integrator (SI) to ensure that the right catalogue number is selected for the right IO board. The SI may decide to 'tweak' the Wake Advance parameter based on sensor performance

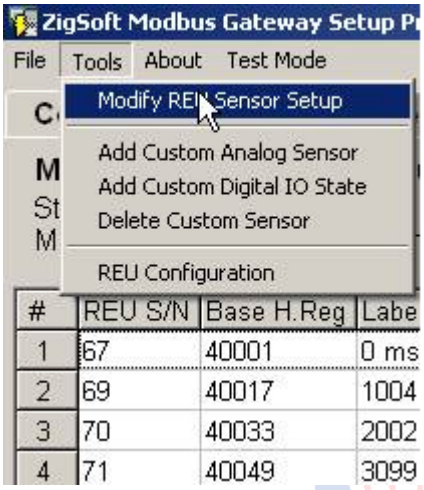
Only active nodes that have joined and are actively communicating with the gateway will be listed

12.4 Modify REU Sensor Setup

The ability to configure and modify sensor data was introduced in order to assist system integrators to monitor known sensor's data and calibrate ZigSoft Modbus values.

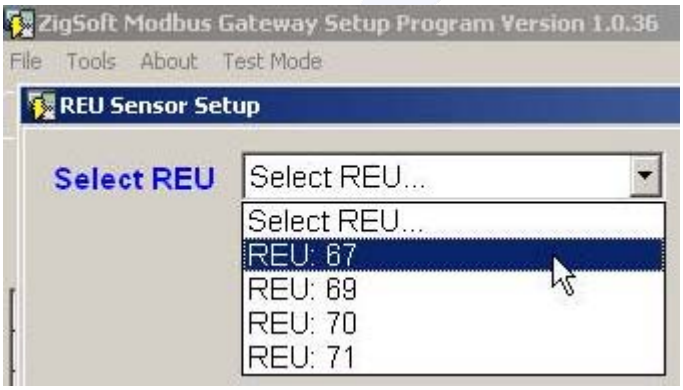
The values are calibrated & displayed in ZigSoft Modbus table only. Modbus Holding registers within the gateway contains raw data only

From the Tools menu select the Modify REU Sensor setup option

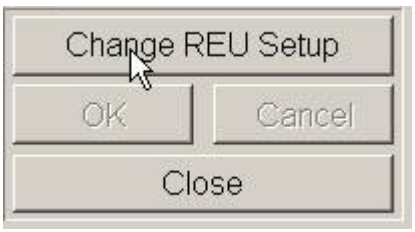


The sensor setup table for the specific REU will open up.

Select the specific REU S/N you wish to configure from the list

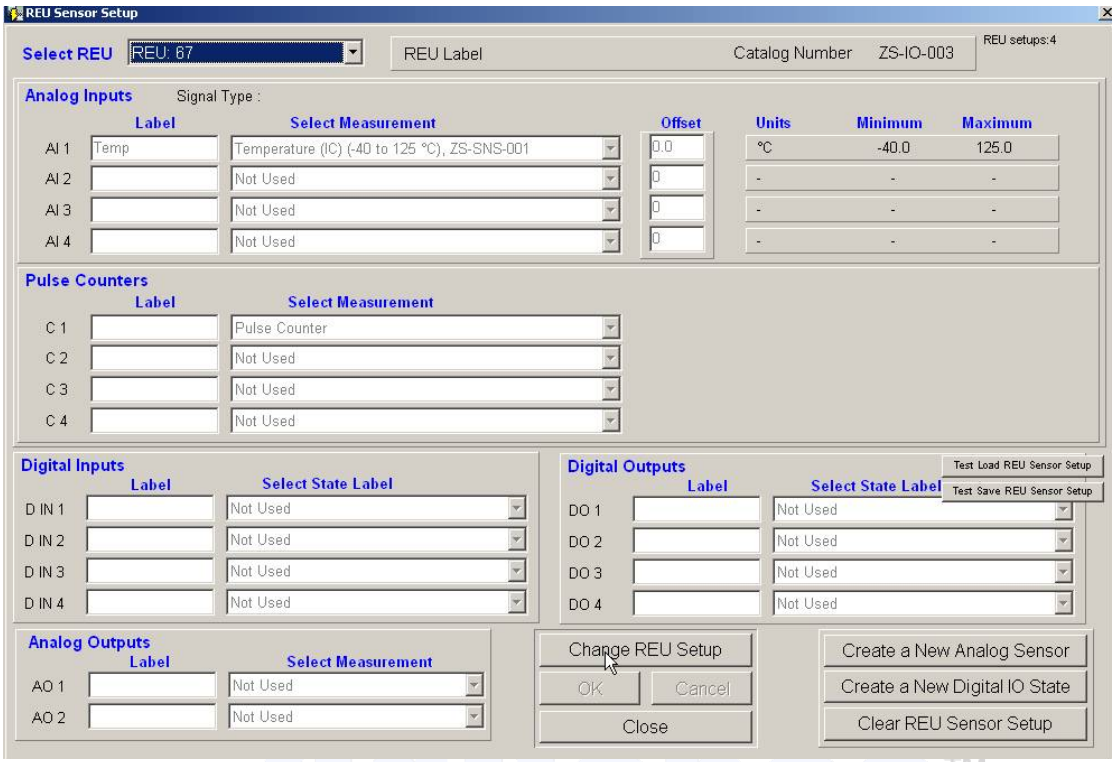


Select the Change REU Setup if you wish to add, remove or modify sensor details

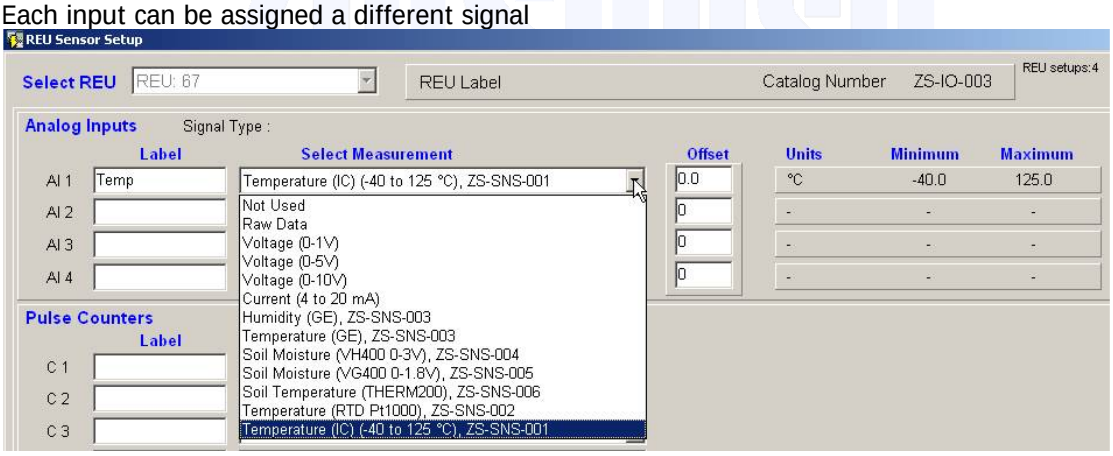


12.4.1 Sensor Setup Table

Each input can display its Analog or Digital parameters as scaled values if defined.
"Not Used" indicates that no sensor or any other parameters was defined



Open the measurement list to view a list of pre-defined sensors or general signal levels.
Each input can be assigned a different signal



Starting with ZigSoft ver.1.34 a new concept of sensors Library .ini file was introduced. This file holds information pertaining to calibrated sensors or range of known input signals. The same calibrated data can later be used to display scaled values in the ZigSoft Modbus table. During installation the .INI file is installed in this location:
C:\Program Files\Conlab\ZigSoft\deviceinfo\zigsoft standard sensors library.ini

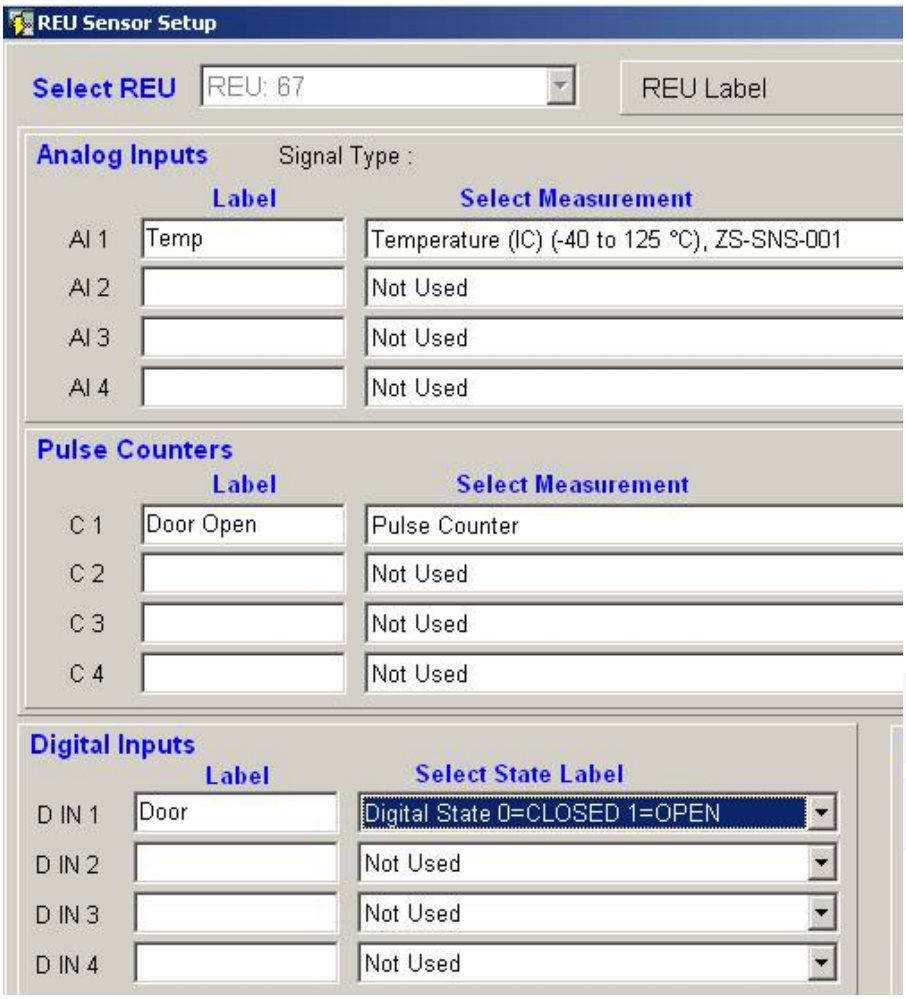
When ZigSoft is first run a new folder will be created as follows:

Win XP: C:\Documents and Settings\All Users\ZigSoft\zigsoft standard sensors library.ini
Win 7: C:\Users\public\public document\ZigSoft\bin\ zigsoft standard sensors library.ini

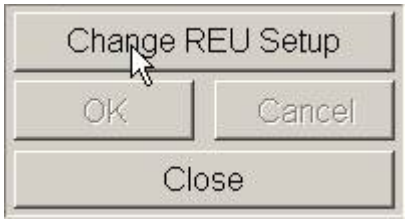
If you wish to send an updated ini file to your clients (or receive a new one from your supplier), ensure to replace the original sensor library .ini file in all public folders

12.4.2 Sensor Setup Selection

When defining a sensor or an input signal range, it is up to the system integrator to ensure the correct sensor parameters are selected. The SI can define an offset value to the sensor reading based on comparing measured data with a known and trusted reference. The SI can enter a label name (text) to identify each input as shown below



Once done, select the OK button and close the setup page to update the Modbus Table



12.4.3 Viewing scaled values in Modbus Table

In the ZigSoft Modbus table shown below you can see the results of the sensor setup table defined earlier.

Example:
Holding Register 40009 refers to AI1 (Analogue Input #1 of REU S/N 67)
Raw data = 1712 is the result of a Temperature sensor wired to AI1. The same Temperature sensor data was scaled and converted in ZigSoft Modbus table to: 23.1 Deg C

Assuming a PLC or SCADA station is connected to the gateway Modbus port and is set to read the same data coming out of Holding Registers data address 40009.

The system integrator (SI) now knows what results (raw or scaled) to expect when programming their scaled data in the PLC or SCADA station application

ModBus Address Table
Status : Monitoring

Freeze Display | Print

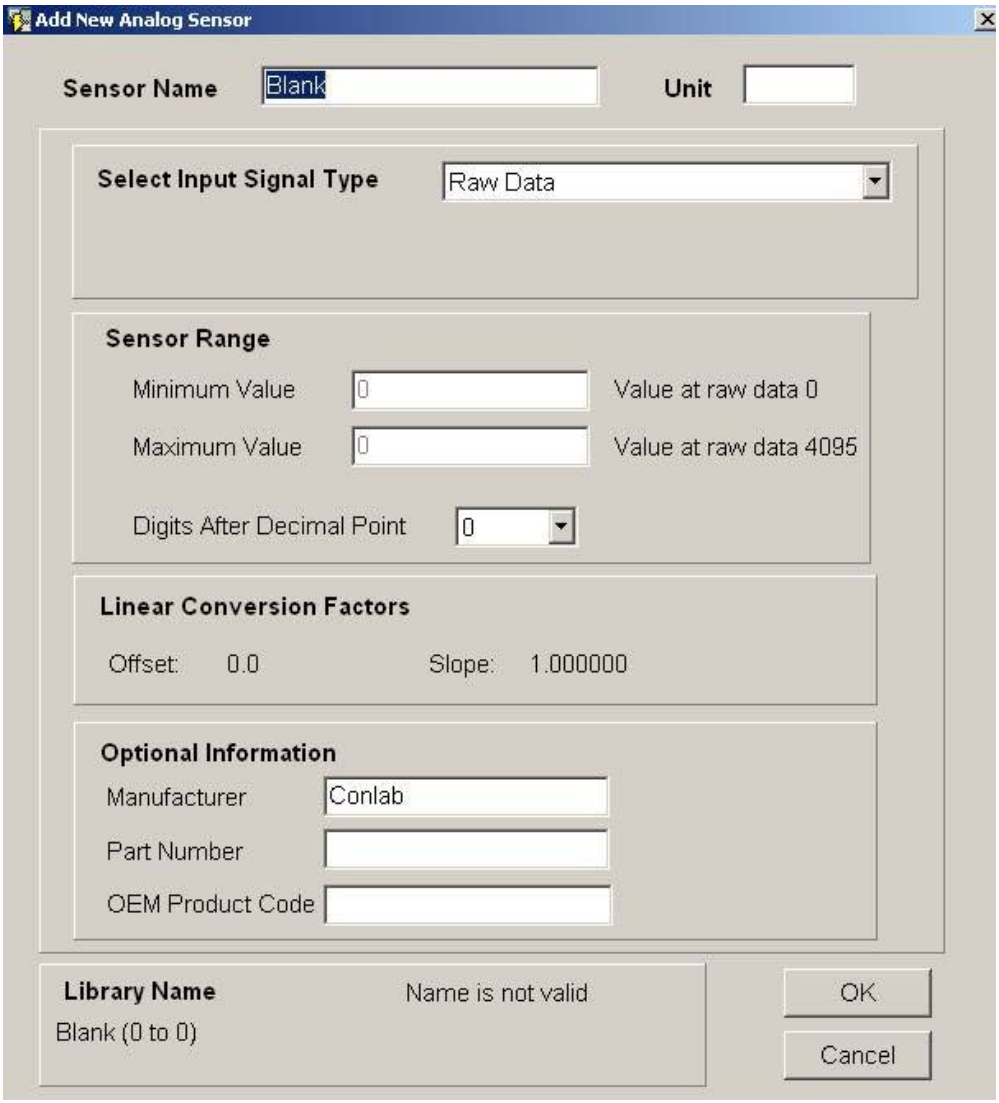
#	REU S/N	Label	H. Reg	Holding Register Name	Value		Converted	Unit	User Label
1	67		40001	Fault Status	0				
		ZS-IO-003	40002	Status	1	Mains OK			
			40003	Battery Voltage	3872		3.6V	V	
			40004	Int. Temperature	139		20.1	°C	
			40005	Digital Inputs	15	Door: CLOSED			
			40006	Digital Outputs	0				
			40007	AO1	0				
			40008	AO2	0				
			40009	AI1	1712		23.1	°C	Temp
			40010	AI2	21				
			40011	AI3	22				
			40012	AI4	25				
			40013	C1	5		5		Door Open
			40014	C2	0				
			40015	C3	0				
			40016	C4	0				

12.4.4 Define a new sensor

ZigSoft enables the system integrator to define a new sensor and add it to the existing sensors list.

Select the Create a New Analog (or Digital) Sensor button either from the Tools menu or from within the sensor Setup Table page

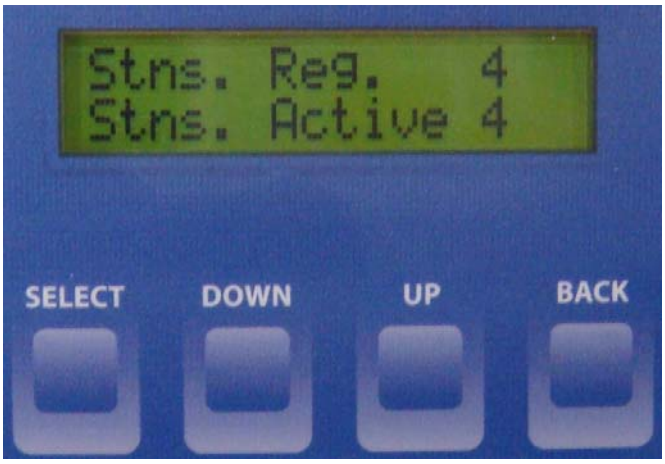
You are now ready to define your own sensor (or generic signal), its units, scaling etc. Once saved, the next time you open the REU Sensor Setup list, your unique sensor will appear in that list ready to be assigned to any input



20.0 TROUBLESHOOTING

20.1 Communications Indicators - Monitoring the gateway LCD display

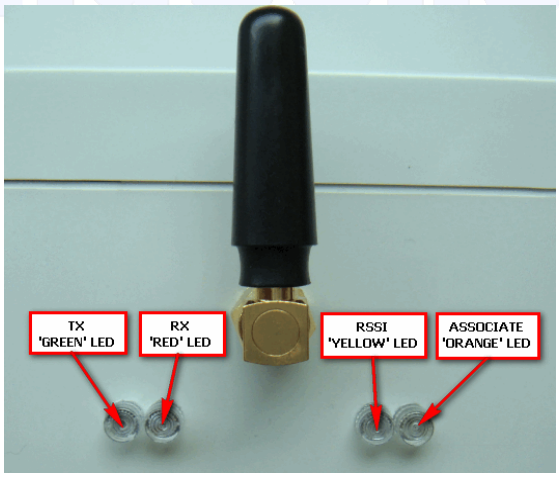
Stns. Reg. XXX – Indicates the overall number of REU nodes already joined the gateway
Stns. Active. YYY – Indicates the overall number of REU nodes currently communicating (Active) with the gateway



The number of active stations will be smaller then the number of registered stations Should any of the below conditions occur:

- A previously Joined REU has lost communications to the gateway
- The REU stopped communicating with the gateway due to power fault
- The REU lost communications to the gateway due to poor wireless conditions

20.2 Communications 'health' Indicators - REU LED



REU LED communications indicators flash whenever the REU is awake and is sending data to the gateway. The default wake-sleep frequencies are: Every 5 seconds (under external power supply) or every 30 seconds when the REU is powered by its internal 3.6VDC Lithium battery. If no LED is flashing check:

- REU is in sleep mode – if lost COMMs to gateway for a very long time
- REU never joined the gateway – needs to manually JOIN or REJOIN the gateway
- REU has lost power supply and internal battery is flat or missing
- The REU is faulty

20.3 Analysing Communications 'health' indicators in ZigSoft

REU 44 normal communications.

Age counter value will reset whenever REU wakes up and is sending data to the gateway

Monitor
Status : Monitoring
Message: Data Packet from REU 54

Freeze Display | Print | Save As CSV

#	REU S/N	Base H.Reg	Label	Time	Status1	Batt	DI	DO	AI1	AI2	AI3	AI4	C1	C2	C3	C4	Rx Ctr	Age	RJ	Miss
1	54	40001		11:04:14	1	3.5V	14	0	4095	4095	4095	4095	0	0	0	0	13	0	0	0
2	44	40017		11:04:05	1		6	0	23	23	26	24	0	0	0	0	12	7	0	0

REU 44 may have lost communications to gateway

Time stamp in RED and miss column = 1 in RED. Age Counter start counting up = 26

Monitor
Status : Monitoring
Message: Data Packet from REU 54

Freeze Display | Print | Save As CSV

#	REU S/N	Base H.Reg	Label	Time	Status1	Batt	DI	DO	AI1	AI2	AI3	AI4	C1	C2	C3	C4	Rx Ctr	Age	RJ	Miss
1	54	40001		11:04:34	1	3.5V	14	0	4095	4095	4095	4095	0	0	0	0	15	0	0	0
2	44	40017		11:04:05	1		6	0	23	23	26	24	0	0	0	0	12	26	0	1

REU 44 still not communicating to gateway

Time stamp in RED and miss column = 2 in RED. Age Counter start counting up = 36

Monitor
Status : Monitoring
Message: Data Packet from REU 54

Freeze Display | Print | Save As CSV

#	REU S/N	Base H.Reg	Label	Time	Status1	Batt	DI	DO	AI1	AI2	AI3	AI4	C1	C2	C3	C4	Rx Ctr	Age	RJ	Miss
1	54	40001		11:04:44	1	3.5V	14	0	4095	4095	4095	4095	0	0	0	0	16	0	0	0
2	44	40017		11:04:05	1		6	0	23	23	26	24	0	0	0	0	12	36	0	2

REU 44 still not communicating to gateway

Time stamp in RED and miss column = 4 in RED. Age Counter start counting up = 65 in RED
REU 44 information bar is in RED and YELLOW background → **Communications were lost!**

Monitor
Status : Monitoring
Message: Data Packet from REU 54

Freeze Display | Print | Save As CSV

#	REU S/N	Base H.Reg	Label	Time	Status1	Batt	DI	DO	AI1	AI2	AI3	AI4	C1	C2	C3	C4	Rx Ctr	Age	RJ	Miss
1	54	40001		11:05:14	1	3.5V	14	0	4095	4095	4095	4095	0	0	0	0	19	0	0	0
2	44	40017		11:04:05	1		6	0	23	23	26	24	0	0	0	0	12	65	0	4

REU 44 still not communicating to gateway

Time stamp in RED and miss column = 5 in RED. Age Counter = 65535 in RED
In Monitor Table: information bar is in RED and YELLOW background → **COMMS lost**
In Modbus Table: Fault status Register (Age) = 65535
In Modbus Table: Status Register = 3. Bit 1 = external DC power. **Bit 2 = Time Out**
To monitor communications loss alarm condition: Monitor Status register bit 2

Monitor
Status : Monitoring
Message: Data Packet from REU 54

Freeze Display | Print | Save As CSV

#	REU S/N	Base H.Reg	Label	Time	Status1	Batt	DI	DO	AI1	AI2	AI3	AI4	C1	C2	C3	C4	Rx Ctr	Age	RJ	Miss
1	54	40001		11:05:34	1	3.5V	14	0	4095	4095	4095	4095	0	0	0	0	21	0	0	0
2	44	40017		11:04:05	3		6	0	23	23	26	24	0	0	0	0	12	65535	0	5

REU 44 Normal communications have resumed

Age counter resets to 0. Miss counter retains total Miss counter **= 6** Time Stamp continues
Modbus Table: Fault status Register (Age) = 0 **Modbus Table:** Status Register = 0.
To monitor communications loss alarm condition: Monitor Status register bit 2

Monitor
Status : Monitoring
Message: Data Packet from REU 44

Freeze Display | Print | Save As CSV

#	REU S/N	Base H.Reg	Label	Time	Status1	Batt	DI	DO	AI1	AI2	AI3	AI4	C1	C2	C3	C4	Rx Ctr	Age	RJ	Miss
1	54	40001		11:05:54	1	3.5V	14	0	4095	4095	4095	4095	0	0	0	0	23	0	0	0
2	44	40017		11:06:00	1		6	0	24	23	23	23	0	0	0	0	13	0	1	6

30. APPENDIX A

DECODING SENSORS DATA VALUES IN MODBUS HOLDING REGISTERS

The following formulas should be used by the system integrator when interfacing an external device to the gateway.

Reg Value is the raw data read in a given Holding Register

Inputs signal	Type	Range	Formula
Analog Input	Voltage	0 – 1V	V = (1/4095) * Raw Data
Analog Input	Voltage	0 – 5V	V = (5/4095) * Raw Data
Analog Input	Voltage	0 – 10V	V = (10/4095) * Raw Data
Analog Input	Current	0 – 20mA	I = (Raw Data /4095)*20
Temperature sensor Analog Input	Voltage	-50 to 124.8 Deg C	Temperature (C°) = [(124.8-(-50)/4095] * (Raw Data) – 50
RTD Pt-1000 Temperature Analog Input	Resistance	-44 – to +128 Deg C	Temperature (C°) = [(128-(-44)/4095] * (Raw Data) – 44
%Relative Humidity 0% to 100% Analog Input	Voltage	0 to 1V	%Relative Humidity = (Raw Data/4095)*100
Temperature -50 to + 150 Deg C Analog Input	Voltage	0 to 1V	Temp=(Raw Data/4095)*200-50
REU Lithium Battery	Voltage	0 to 3.7V	V = (Raw data/256)*3.764
REU CPU Temp.	Temperature		CPU Internal Temp = 25-((2500 * (1024 + Reg Value) / 4095)-701.2) / 1.769

40. XBee Specifications

RF Network	ZigBee mesh	ZB PRO Features
Radio Frequency	2.4GHz	
Radio technology	DSSS, ISM	
RF Data Rate	250Kbps	
CGU TX Power LO	+10dBm MAX	Low Power
CGU TX Power Hi	+ 18dBm MAX	High Power
REU TX Power LO	+10dBm MAX	Low Power
REU TX Power Hi	+ 18dBm MAX	High Power
No of channels LO	16	Low Power
No of channels HI	14	High Power
Sleep mode	End Point only	Current < 20µA
CGU (Coordinator) DC Power supply Battery	**+24VDC MAX**, 500mA 2 x 3.6VDC 2.1A/h Rechargeable Lithium	TX 300mA MAX @100 mSec TX pulse
REU (End Point) DC Power supply Battery	**+12VDC MAX**, 500mA 1 x AA 3.6VDC 2.1 A/h Lithium Non Rechargeable	TX 300mA MAX @100 mSec TX pulse Sleep Current <20µA during sleep mode
CGU Dimensions (mm)	160(L) X 90(W) X 60(H)	
CGU Weight (grams)	500	With batteries
REU Dimensions (mm)	120(L) X 90(W) X 60(H)	
REU Weight (grams)	260	With battery
FCC ID:		MCQ-XBEEPRS2B
Australia	C-Tick	C-Tick

IF YOU USE THE REU OWN DC POWER SUPPLY TO POWER AN EXTERNAL SENSOR, PLEASE ENSURE THAT THE SENSOR'S POWER REQUIREMENT DO NOT EXCEED THE 12VDC SUPPLY VOLTAGE AND MAXIMUM CURRENT

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